OFFICIAL
BULLETIN
OF THE

NATIONAL DENTAL ASSOCIATION

VOL. 1
NO. 4

OCTOBER, 1914

CONTENTS FOR OCTOBER, 1914

Page

Donald M. Gallie, D. D. S. ..... Frontispiece

Greetings,
By Donald M. Gallie, D. D. S. 1

Our President, Verse 2

President's Address,
By Homer C. Brown, D. D. S. 3

The Functions of Dentistry and Medicine in Race Betterment,
By Victor C. Vaughan, M. D. 14

Dental Caries,
By Russell W. Bunting, D. D. S., and U. G. Rickert, B. S., M. A. 16

Report of the Mouth-Infection Research Corps (Illustrated)
By Thomas B. Hartzell, M. D., D. D. S.,
Assisted by Arthur T. Henrici, M. D., and Harold J. Leonard, D. D. S. 48

Metallurgical, Physical, and Electro-Chemical Researches,
By Weston A. Price, M. S., D. D. S., and Frank A. Fahrenwald, E. M. M. S. 71

Special Researches in Physics,
By Weston A. Price, D. D. S., M. S. 110

Reports of Researches in Progress under the auspices and support of the Scientific Foundation and Research Commission 122

Transactions of the Eighteenth Annual Meeting—First General Session 124

Reports of Researches of the Scientific Foundation and Research Commission—Second General Session 130

Proceedings of the House of Delegates 132

Report of Committee on President's Address 133

Constitution and By-Laws and Code of Ethics 136

The Nine Districts for 1914 150

The National Meeting,
By Otto U. King, D. D. S. 152

Editorial 155-162

Our President.——Our New Cover.——The National Dental Journal.——National Journal to be a Continuation of the Official Bulletin.——The Rochester Meeting.——Progress of the Scientific Researches.——Governmental Delegates to Sixth International Dental Congress.——Dr. Belcher Re-Enters Editorial Field.——Special Notice to Non-Members.

General Secretary's Summary for 1914-15 163

General Secretary's Office; Printing and Mailing Bulletin ..... Half-tones 166-167

Officers and Committees 168

Announcements and Items of Interest 170-175

International, National and State Society Meetings, Special Notice, Federation Dentaire Internationale, Dental Protective Association of the United States 170

The Panama-Pacific Dental Congress 172

National Dental Association, Some Startling Facts, Short Papers the Best Papers 173

Strengthening Educational Requirements, The Swindler Arrested 174

Newspaper Comment 175

The Municipal Auditorium in San Francisco ..... Half-tone 176

DONALD MACKAY GALLIE, D. D. S., Chicago, Illinois.

President National Dental Association; Professor Operative Dentistry, University Illinois; Ex-President Illinois State Dental Society; Chicago Dental Society; Odontographic Society of Chicago, and Institute of Dental Pedagogics.

Official Bulletin

—OF THE—

National Dental Association

VOL. 1 OCTOBER, 1914 No. 4

Greetings.

FOR years those interested in Dental Societies and the advancement of our profession, have hoped for and dreamed of a National Association which would be national in name, numbers, character and field of usefulness.

This hope was realized, this dream came true in Rochester July 7th, 8th, 9th and 10th, for here was held the first meeting of the reorganized National Dental Association.

And what a splendid meeting, held in a city ideal in every respect, providing unexcelled facilities for convention purposes, arranged for by a local committee that left nothing undone for the comfort of member, exhibitor and visitor.

A literary program of unusual excellence, including among the essayists a number of the brightest and best known medical men in the country, who presented papers of vital importance to dentists; a report of, and papers by members of the research committee, which clearly demonstrates that this splendid work is being carried on by men of unquestioned ability, and highest efficiency; the clinics were of the highest order and were conducted in a manner that made it possible for practically everyone in attendance to see all demonstrations; exhibits of dental goods were without doubt the finest ever made; and the crowd splendid.

These things in themselves would make the Rochester meeting one of the best in the history of the National Association.

But there was something greater and more important than good crowd, program, clinic, and exhibits in evidence in Rochester, a something that could be felt, but hard to describe. It was the spirit of fellowship and harmony, the evidence of earnestness and the desire on the part of all to perfect the organization.

It was gratifying to see the Old Guard who labored for years in the interest of the National working side by side with the delegates from the different States, many of whom were attending their first National meeting. All seemed to realize that harmony and earnest effort were necessary to set into smooth running order the machin-

ery for a society which had grown from a membership of nine hundred to one of thirteen thousand within twelve months. What a splendid achievement! What a debt the profession owes to the men who organized, and gave time, money, and energy in behalf of the society, and to the men who had the vision of the necessity of a greater National, a society that in every way would be in keeping, and represent the position and importance that our profession has attained.

Think of the possibilities of this great organization and its component bodies! First the State Societies, and the component bodies within the State, the interest and influence of the dentist located in the smallest town in the remotest State can be felt in the parent organization.

The great activity in dental organization manifested throughout the whole country and the keen healthy rivalry of States for greater representation in the National, will bring the membership up to twenty-five thousand within a few years. With such an organization there will be no limit to the good that can be accomplished in scientific research, education and legislation.

Let every State strive to substantially increase its membership during the next twelve months. Do not be satisfied with your present representation in the house of delegates and at the next annual meeting be not content with sending your delegates, but let us strive to see which State can send the largest percentage of her membership to the annual meetings of the National.

In the election to the presidency of the National Dental Association, I am deeply sensible of the great honor you have conferred upon me.

I am not unmindful of the duties and responsibilities that accompany the honor, but with the support of a loyal membership I feel that next year's work will be gratifying to all.

Fraternally,

DONALD MACKAY GALLIE.

Our President.

"HIS tongue was framed to music,
And his hand was armed with skill,
His face was the mould of beauty,
And his heart the throne of will."

PRESIDENT'S ADDRESS

By Homer C. Brown, D. D. S., Columbus, Ohio

(Delivered at the Eighteenth Annual Session of the National Dental Association, Rochester, N. Y., July 7, 1914)

I HAVE every reason to be deeply sensible of the confidence of my associates as was evidenced by having been unanimously elected President of the National Dental Association. This preferment, the highest honor the dental profession can confer upon one of its members, was accepted with a full appreciation of its responsibilities and with an avowed determination that the best interests of our Association would receive my most careful and thoughtful attention.

I wish at this time to express my sincere appreciation to the officers, committees and the individual members for such assistance and co-operation as they have rendered. Without their full support it would have been impossible to have accomplished satisfactory results. We should be very grateful for the co-operation of the medical profession, as is evidenced by the prominent members contributing to our program. This is but a continuation of the splendid spirit that has been shown throughout the year in state and local meetings, in a modified way.

Rochester as a Meeting Place.

It is seemingly apropos that our Association should meet this year in Rochester since the question of relation of the mouth to general systemic conditions is receiving so much attention at this time. The Rochester Dental Society has been a pioneer in the dissemination of the oral hygiene propaganda and if I mistake not the results accomplished have been responsible for this beautiful city receiving considerable publicity of the kind that is worth while. I commend those who have been active in this work, which includes such citizens and public officials as have contributed in any way to making this possible

Review of the Year's Work.

This being the first meeting since the reorganization I feel that it may be interesting to review the work of the past year.

In the first place, I desire to announce that the chairman of the Local Committee of Arrangements of the Kansas City meeting forwarded a draft for $1144.36, which was duly acknowledged, with thanks, in the name of the Association.

In accordance with authority granted at Kansas City, and in addition to the officers and the Oral Hygiene Committee, the following were appointed delegates to the Fourth International School Hygiene Congress held in Buffalo, August 25th to 30th:

Dr. Robin Adair, Atlanta, Ga.
Dr. L. L. Barber, Toledo, Ohio.
Dr. W. W. Belcher, Rochester, N. Y.
Dr. L. George Beerbower, Terra Alta, W. Va.
Dr. C. B. Bratt, Pittsburg, Pa.
Dr. C. L. Brininstool, Rochester, N. Y.
Dr. Holly V. Brockett, Kansas City, Mo.
Dr. J. P. Buckley, Chicago, Ill.
Dr. H. J. Burkhart, Batavia, N. Y.
Dr. Charles S. Butler, Buffalo, N. Y.
Dr. Samuel P. Cameron, Philadelphia, Pa.
Dr. J. P. Corley, Sewanee, Tenn.
Dr. H. D. Chipps, Corinth, Miss.
Dr. J. V. Conzett, Dubuque, Iowa.
Dr. W. G. Ebersole, Cleveland, Ohio.
Dr. Thomas B. Hartzell, Minneapolis, Minn.
Dr. W. Smith Frankland, Washington, D. C.
Dr. Richard Grady, Annapolis, Md.

Dr. W. E. Grant, Louisville, Ky.
Dr. H. Clay Hassell, Tuscaloosa, Ala.
Dr. Gillette Hayden, Columbus, Ohio.
Dr. N. S. Hoff, Ann Arbor, Mich.
Dr. George E. Hunt, Indianapolis, Ind.
Dr. Louis Meisburger, Buffalo, N. Y.
Dr. P. B. McCullough, Philadelphia, Pa.
Dr. T. T. Moore, Jr., Columbia, S. C.
Dr. W. H. Potter, Boston, Mass.
Dr. Weston A. Price, Cleveland, Ohio.
Dr. Frederick W. Proseus, Rochester, N. Y.
Dr. Sidney J. Rauh, Cincinnati, Ohio.
Dr. J. J. Sarrazin, New Orleans, La.
Dr. B. Holly Smith, Baltimore, Md.
Dr. W. W. Smith, Rochester, N. Y.
Dr. J. D. Towner, Memphis, Tenn.
Dr. J. H. Wallace, Omaha, Neb.
Dr. Herbert L. Wheeler, New York City.
Dr. W. A. White, Phelps, N. Y.

This was a very important Congress and much good should result from its activities. A goodly number of dentists from this and other countries were in attendance and a number of very interesting and instructive oral hygiene papers were presented. These are published in the proceedings, which were recently distributed to the members, and will do much to stimulate an increased interest with those connected with school and health matters and this should be far reaching in its effect.

In this connection, I desire to call attention to the 1914 meeting of the American School Hygiene Association which is to be held in Philadelphia, Sept. 22nd to 24th, in conjunction with the Fourth International Congress on Home Education. Our profession has been recognized by an officer of our Association being elected a member of the council of the School of Hygiene Association. It is recommended that we express our approval of the purposes of this Association as well as those of the Race Betterment Congress and that our Association appoint delegates to both. I also recommend that future presidents be authorized to name delegates to such meetings as would, in the judgment of such an officer, be either desirous or advantageous.

So far as your president is informed, the National Dental Association has never heretofore had more than 600 to 800 members, while at this time we have more than 12500 paid members, with several State Societies which have not held their 1914 meeting. The time for final reporting, in order to be represented in the House of Delegates, was advanced to July 6th. When all the details of our present relations are better understood by the members and officers, reports will reach our General Secretary more promptly. In view of these facts our membership should increase to 16,000 or 18,000 within a reasonable time.

The General Secretary's office has been furnished with such equipment as is nessessary to conduct the affairs of the Association in a business like and systematic way. In order to start right this equipment has been expensive but necessary. When it is understood that the greater part of this cost can be considered as an investment that can be very properly prorated over a period of several years, we can better appreciate that this has been a critical year from a financial viewpoint.

It is generally considered that any new movement or plan of organization requires more or less detail work in order to properly stimulate it and for that reason it has been necessary to give careful attention to a number of the state societies with a view of securing their co-operation. Your president has attended a number of these meetings and during the year has traveled approximately 10,000 miles in order to render such service as seemed to be for the best interest of the Association. Further, it was thought advisable to send night letter telegrams of greetings to such of these societies, as we had their dates of meeting.

In order to stimulate the graduates of this year to promptly affiliate with our dental organizations, your President addressed a letter to the Deans of the various dental colleges and enclosed a circular letter addressed to the 1914 graduating classes. The status of our profession and of our organizations was reviewed in the letter to the graduates and the Deans were requested to read this to their senior class and supplement it with such other suggestions as seemed to them appropriate.

At the urgent solicitation of some of the southern members, your president attended the joint meeting of the Southern Branch and the Georgia State at Atlanta, June 4th to 6th, and presented a paper on "The Status of our Dental Organizations." In this it was advocated that the Southern Branch discontinue and that the same energy required to make this an efficient organization be directed in building up the southern state societies, as constituents of the National. However, I assured them of our willingness to cooperate in every possible way if a majority of the Southern members desired to continue this Branch. Suffice to say, it was decided by unanimous vote to discontinue and the Georgia State promptly voted unanimously to become a constituent with her full membership. Similar action has been taken by every southern society meeting since then, all of which assures that the "Solid South" is loyally co-operating. I am of the opinion that it will be advisable to concentrate our efforts on the local society as a component of the state and state society as a constituent of the National.

Conditions of Organization.

So far as your president is advised every state society that has taken final action relative to becoming a constituent, with one exception, has done so by bringing into the National its full membership. The action to this effect in West Virginia and Texas, does not become compulsory until 1915. Some societies have a liberal provision in their by-laws for carrying their members two or three years before dropping them. In such cases their state membership may be considerably larger than their membership in the National. It should be recommended to these societies that they amend their constitution and by-laws in order to keep the membership lists in harmony. If dues cannot be collected from a member for their current year it becomes more difficult when a member is in arrears for two or three years.

It would seem with the very excellent start and the interest manifested in all sections of the country in our local, state and national organizations that this would assure the success of our Association. But it must be fully recognized that for the next two or three years it will be important that there be a concerted effort put forth to not only maintain the present interest but to in every possible way stimulate and increase this interest in all these organizations.

The maximum strength of our National Dental Association is wholly dependent upon the state societies as constituent members thereof, and in many instances this automatically reverts to the component societies of the State organizations. The development of this maximum strength makes possible the conserving of those professional ideals which are worthy of retention; the advancing of our standards in order to keep pace with healthy progress; the encouraging and supporting of officers, committees, and those who contribute to our programs, as well as those qualified to do scientific research work; the fostering of the fraternal spirit, and the broadening of the individual. All of these are things worth while and only made possible through efficient and well managed organizations. The officers, more than all others, will be held responsible for the development of our National Dental Association into a strictly representative, harmonious, co-operative and influential

organization, which will make possible the advancement of our profession, thus assuring a more efficient service to afflicted humanity.

Panama-Pacific Dental Congress.

The profession of our extreme Western states has arranged, in connection with the Panama-Pacific Exposition, to hold a Dental Congress in San Francisco beginning August 30th, 1915. The Organization Committee was represented at the Washington meeting and extended an invitation to the National Dental Association to postpone the 1915 meeting and meet in connection with this Congress. The matter was presented to the executive council and with their approval was referred to the Association, which voted unanimously to accept the invitation. We bespeak for this Congress the good offices and co-operation of the organized dental profession.

Miller Memorial.

Another prominent feature for next year will be the unveiling of a Memorial in honor of the late Dr. Willoughby D. Miller, in recognition of services rendered the dental profession and humanity. This will take place at the time of the Fiftieth Anniversary meeting of the Ohio State Dental Society, the first week of December, 1915. The Memorial is to be erected on the lawn of the Public Library in the city of Columbus, Ohio, Dr. Miller's native state.

National Dental Journal.

The question of a National Dental Journal is the most important one confronting our Association at this time and should receive the most careful consideration of the House of Delegates, to the end that the best interests of the Association and the constituent societies will be served. This, in the final analysis, means the best interests of the individual members. We must recognize that it has generally been understood that whenever a Journal is published and furnished our members the dues will be increased to $2.00.

Your president is of the opinion that there are at least two practical solutions of this question; First, the publishing of a National Dental Journal, commencing Jan. 1st, 1915, and increasing the dues for next year. Second, continue the dues at $1.00 and continue the Bulletin, publishing the proceedings therein, as well as publishing such other meritorious articles from the dental and medical professions as may be secured. The general type of the Bulletin can be improved and we may be justified in changing the name to the National Dental Journal, as a quarterly publication for 1915. Such a procedure would avoid the criticism that would naturally follow an increase in dues for our second year.

We recognize that whatever is done it will be impossible to meet the approval of everyone and we must expect some general criticism of this and every other important question. Therefore, it would seem advisable to use every precaution to safeguard our action in every possible way and hope for support that will be lasting.

Our constitution and by-laws provide that the Board of Trustees are to have full control of the Journal, but appreciating the fact that this Board is more or less a changeable body because of the provision against a member serving more than one full term as a Trustee, it would seem that the future of the Journal could best be promoted by a Journal Commission. The Trustees have charge of the general business affairs of the Association and could elect a Commission of fifteen to have entire control of our Journal, subject to their approval. The Journal is already a part of the prescribed duties of the Trustees and a Commission of their selection could give more attention to details and produce better results. This Commission could be elected, five for one year, five for two

years, five for three years and five annually thereafter.

The members of such a Commission should be selected because of their qualifications and with the idea that they devote the time necessary to work out questions of vital interest to the Journal and the profession. Financial questions in connection therewith would have to be here submitted to the Trustees for their approval. This Journal, when established, should be all that the profession has a right to expect. In addition to publishing our proceedings and notices it should be of such high type as to attract the best writers in the dental and medical professions and it is very important to take such positive steps as would indicate that the Journal's interests are to be amply safeguarded. This will develop confidence and stimulate an interest in its support.

I am of the opinion that if our Journal is placed on this basis that there will be less difficulty in securing the services of a capable editor, who will reflect credit upon the Journal and the Association. Further, I am of the opinion that such a person can be secured for an indefinite period without any great expense to the Association. We all appreciate the necessity for viewing the economic side of the question for the first few years and it is possible that some of our best equipped men will not fail to recognize the opportunity for improving conditions and will be willing to generously contribute to that end.

Increasing Educational Standards.

A careful study and an impartial analysis of the educational question shows that an increase in the equipment of the dental graduate is clearly indicated.

Dentistry as a profession can claim a history of only three quarters of a century. Much progress has been made during this whole period, but the first decade is especially noteworthy for its achievements: The first dental college was established; the first dental society was organized; the first dental Journal was published; Horace Wells gave to suffering humanity the first known anæsthetic, Nitrous Oxid, and William T. G. Morton announced to the world the use of Sulphuric Ether. These are notable achievements in our history and the two last have been important factors in the progress of civilization.

The present decade, of which we will assume this is the fifth year, should be productive of such development and progress as to make this surpass any former two decades in the history of our profession. The bringing together of the organized profession of our country into one compact representative organization, whereby it will be possible to accomplish results which have heretofore been considered impracticable, is an achievement that should meet with the general approval and the loyal support of all interested in our advancement. The work of the Research Commission is an evidence of what can be accomplished through a concerted effort backed by an effective organization. If I mistake not, the closing portion of this decade will see more advancement than many of us would even think of prophesying at this time.

The fact that the medical profession, health and educational authorities, civic and philanthropic organizations, as well as the laity, are looking to us for cooperation and relief as never before, prompts me to say that we must appreciate our responsibilities and improve our opportunities. To do this, and merit the confidence of these interests, we must necessarily increase or strengthen our dental college curriculum, and this will call for a lengthening of the time required to complete the college course and receive the dental degree.

The instruction received in most of our dental colleges in histology, pathology and bacteriology is so meager that the present graduate is not sufficiently versed in these to consider it a prepara-

tory course which would admit to more advanced work. Considering our profession from its present day view point these are fundamental subjects and of vital importance to the success of the young dentist.

We will with more or less humiliation admit that few of our practitioners of to-day are sufficiently educated in these particular subjects to reflect the credit upon the profession that we would like to receive at this time. We must admit that only a limited per cent will be capable of meeting these requirements, except such as take a special course in order to better qualify in this class of practice, but we are not alone in our weakness and what I wish to do is to stimulate and not to discourage.

Confronted as we are, it behooves us to meet the present conditions in a frank and fearless manner, making such preparation for the future as the emergencies of the situation would seem to merit. The preliminary educational requirements for matriculation should be advanced and there is no better way to accomplish this than to have specific requirements incorporated into our various state dental laws. This can be done by specifying the course of study necessary prior to receiving a diploma which is to be accepted as a credential for examination.

It will be recalled that some twelve years ago the college course was advanced from three to four years, but this was only in effect for one year when they returned to the three year course. Some contend that it is impossible to give more hours to these fundamental subjects and, accepting that statement as true, it would seem that the only plausible thing to do is to increase the college course from three to four years. I would not advocate that this be done without ample notice since there should be no hasty action taken that will work a positive hardship upon institutions that have done creditable work in the past. It would seem advisable, if practicable, to permit of such elasticity as will recognize state or sectional educational standards.

We are advised that the Dental Faculties Association of American Universities has already appreciated the need of additional qualification for their graduates and have decided to increase the curriculum and advance to a four year course. They are to be commended for this progressive action, but in order to secure as nearly harmonious relations in dental educational matters, as is possible, it would seem advisable that this advancement be postponed for at least two years, or until the 1916-1917 session, with the hope of securing the co-operation of at least the leading private dental schools.

There is a strong tendency to unification of dental educational and dental board matters and I am convinced that best results will necessarily follow when this is more harmoniously developed and when all professional training will be connected with state universities, or universities of like standing. I say this in the face of the past excellent record of many of the private institutions and with no word of criticism or a disposition to injure their standing. The observing man must appreciate that this is in line with progress, as well as the fact that there is a positive influence associated with the work of the universities that lifts all these educational questions to a higher plane.

Research Commission.

The results accomplished by the Research Commission, within such a brief period, has been most gratifying and has prompted much favorable comment. The Association has been extremely fortunate in having men actively in charge who are particularly adapted to and intensely interested in this work, the most important that our organization has ever undertaken. Other professions and in-

terests have been surprised that the profession has so generously contributed to this fund, to the end that results may be of benefit to the dentist and of far greater benefit to those whom we serve.

The attitude of the profession toward this work has been such that this alone is evidence of our earnest desire to assist in solving some of the unknown problems which tend to retard the efficiency of our citizenship. If we continue this work with the same interest and enthusiasm as we have every reason to believe that the medical profession will cooperate in every possible way, but if we become lukewarm there is no question that the research workers of the medical profession will take advantage of our lack of interest and in this way we will lose our identity in this special work which rightly should be under our control and development.

It is true that the medical profession is particularly fortunate in having at its disposal ample funds, which are necessary to accomplish best results in research work, and this gives them a distinct advantage. Within the last few days press reports have announced that Mr. Henry Ford proposes spending millions of dollars in order to combat that much dreaded disease, cancer. Also, that Mr. John D. Rockefeller has made an additional contribution of $2,550,000 to the Rockefeller Institute of Medical Research, which makes a total of $12,550,000 contributed by him to this Institute. We heartily commend the humanitarian and philanthropic interests shown by these men and others in furnishing funds for such worthy purposes and we can only hope that it will not be long until ample financial aid, from similar sources, will be forthcoming in order that dental research work may be vigorously prosecuted.

The most positive dental recognition is the Forsyth Dental Infirmary at Boston, which will be dedicated at an early date. The cost of the buildings and equipment will exceed $500,000 and it is endowed with $2,000,000 for maintenance and operation. This has been made possible through the philanthropic generosity of John Hamilton and Thomas Alexander Forsyth, whose names will be recorded in history as having rendered a humanitarian service of inestimable value.

In this connection, I may be pardoned for incorporating two paragraphs from former statements I have made. In a paper read before the Northern Ohio Dental Association in 1904, I said: "It would be a blessing to humanity if some multimillionaire would endow an institution with funds sufficient to establish and keep in operation a department for advanced scientific study and research. Thus, in so far as possible, scientifically eliminating the predisposition and environment of dental caries."

Quoting from a report read before the Ohio State Dental Society in 1909: "Unusual conditions may arise over which a dentist, like all others, may have no control and which for the time being may cause a seeming indifference, but professional "dry rot" is not one of these. Therefore, we should arouse ourselves and make a hasty and determined effort to get in accord with the progressive spirit of the present, to the end, that here possibly our devotion to our work, together with the ever increasing tendency toward prevention rather than cure, may in time attract sufficient attention as to be the direct cause of some liberal fund being contributed for the purpose of scientific research work which may eventually reduce that most prevalent disease of civilization, dental caries."

Legislative Committee.

The particular effort of the Legislative Committee for the past few years has been directed in securing legislation in connection with the Army and Navy Dental Corps. This has been of sufficient importance to receive our careful atten-

tion, but it is not the only thing that must be considered as coming within the province of this committee and their duties will become heavier from year to year. Such questions as a National Bureau of Health, patent legislation and any other legislation that relates to questions in which the profession should be interested, will require attention. Such legislation may come up at any time. During the year a bill to renew the Low dental patent was introduced and another with reference to the use of certain drugs will, if passed, place our profession at a distinct disadvantage. I do not know the present status of the bill to renew the Low patent but we stimulated considerable opposition to this from different sections of the country. In order to place our Association on record for future benefit, in similar cases, I recommend that a resolution be passed expressing our disapproval of this kind of legislation.

Relative to House Resolution 6282, which is pending in the Senate at this time, Senator Pomerene, of Ohio, offered an amendment in behalf of the medical profession as follows: "On page 3—after the sixth line, insert:

"Provided further, That this act shall not apply to physicians and surgeons regularly licensed to practice their profession in the State, Territory, or District where they reside, who may prescribe, dispense, or administer said drugs in good faith; nor to nurses or attendants who may dispense or administer in like good faith said drugs under the direction of a physician or surgeon regularly licensed and given in good faith as aforesaid."

My attention was recently called to this and I promptly wrote Senator Pomerene requesting that he substitute the word "dentists" for "surgeons" in the second line and "dentist" for "surgeon" in the next to the last line, as well as "professions" for "profession" in the second. It was necessary to act promptly in this matter and if the Association approves of this I would recommend that a telegram be sent to Senator Pomerene advising him of the official attitude of our Association.

In appointing the Legislative Committee, as well as some other Committees that may be expected to get together to discuss important questions, it would seem advisable to select persons not too far removed from each other. Also, the members of the Legislative Committee should not be too far removed from our National Capitol.

Each state dental society should have a legislative committee whose chairman might very properly be made an ex-officio member of the National Legislative Committee and this would apply equally as well to the Committee on Public Dental Education and Oral Hygiene.

Army Dental Corps.

It is not necessary to present any argument with reference to the need of the Army Dental Corps or the services it is rendering. However, I think there is no question that the status of this corps is not in keeping with that of other corps or such as to render military prestige to its members or reflect credit upon our profession. In military life rank counts for much and while there has been considerable effort in the last few years to improve this condition, yet I am of the opinion that if our reorganized National Dental Association endorse a strong but fair policy, and loyally supports this, there will be no question that the desired legislation will be enacted at some early date.

During the last year a bill was introduced giving recognition to the Veterinary Corps far in advance of that now given to the Dental Corps. We have no disposition to oppose the veterinarians securing this recognition, yet we cannot help but feel that it would mean the lowering of the dignity of our profession and work a distinct disadvan-

tage to the efficiency of the Army Dental Corps if it does not receive equal recognition. Therefore, I would recommend that a Dental Reserve Corps be created. Also, that there be provision for one Colonel in the Dental Corps; not more than 25 per cent of the corps should be eligible to Majorship, and only then after ten years service; a stipulated per cent as Captains and the remainder as First Lieutenants.

Rank regulates both increased pay and position and in order that the service be developed to its highest possible efficiency it is to be hoped that the Surgeon General of the Army will appreciate the need for such legislation and give it his approval. What applies to the Army Dental Corps should apply alike to the Navy Dental Corps.

Liability Insurance.

A special committee has been investigating conditions with reference to providing protection to our members against malpractice and damage suits. We call attention to their report and suggest that this is a matter worthy of careful consideration by the House of Delegates. From information presented it would seem that such protection could be secured for our members at a very low cost and we believe that this will stimulate in many ways an interest in our Association. If possible to furnish this protection without increasing the dues to more than $2.00, when the Journal is published, it would seem advisable to do this. In view of this I recommend that this committee be continued and instructed to see if arrangements cannot be completed by the next meeting so that this protection will become effective Jan. 1st, 1916, or whenever the Journal is published and the dues raised to $2.00.

The National Mouth Hygiene Association.

The question has been frequently asked what relation exists between the National Dental Association and the National Mouth Hygiene Association. Under our present constitution and by-laws there is no provision for this organization as an auxiliary, as was originally planned when this was organized. Attention is merely called to this so that if it is the desire of the National Dental Association to have the National Mouth Hygiene Association co-operating as an auxiliary, there should be some specific provision made whereby their relations will be properly defined and clearly understood.

Committee Question.

In our list of Committees for this year we find several that are not in strict harmony with our constitution and by-laws. Some of these are special committees appointed with some particular duties assigned. Others were directed to be continued by some official authority during the transition period at the last meeting. Such standing committees as are necessary should be retained and in order to do this we suggest that necessary amendments to our by-laws be adopted. Authority for the appointment of such special committees, as may be necessary, should be provided.

I am of the opinion that the work of the Oral Hygiene and the Public Dental Education committees is so closely allied that they could very properly be combined into one standing committee and recommend this. The time has arrived when the necessity for the teaching of Oral Hygiene in our schools must receive attention, and it is recommended that a committee be appointed to prepare a text book on this subject. If we do not do this individuals will probably publish such books and these may not meet with our approval.

"Safety first" is a commendable slogan which should meet with the approval of all, but the health authorities, the physicians and the dentists should fully recognize the importance of prevention first rather than the best possible efforts "to cure." When this is supplemented by

the generous co-operation of an educated and appreciative public, then positive results in race betterment can be expected.

The Committees on National Relief Fund, on Public Health and Dental Museum should be continued. The efforts of the National Relief Committee have been directed in behalf of a worthy cause and I heartily commend their enthusiasm.

I recommend that provision be made for a general conference committee, which should be authorized to confer and co-operate with various allied organizations and that the term of all members of the four standing committees should expire at this meeting, so that they can be selected in accordance with the provisions of the by-laws.

California and District of Columbia.

A question has been raised with reference to two constituent societies in California and two in the District of Columbia. There may be good arguments for and against in both instances, but if it is thought advisable to continue to recognize their two societies it is recommended that representation in the House of Delegates be based upon the total number, instead of upon a basis of two separate societies.

President-Elect.

The experience of the past year prompts me to think that the best interests of the Association will be served if the plan of electing officers is somewhat changed. Therefore, I would recommend that the constitution and by-laws be amended so as to make provision for the election of a President-elect, who serves for one year, which gives him an opportunity to become thoroughly familiar with the affairs of the Association, before assuming the full responsibilities of the presiding officer.

The American Medical Association and a number of state medical organizations, have adopted this plan and I am advised that it is found to be more satisfactory than under former conditions.

The arrangements for electing Vice-Presidents could be annulled, or I can see no objection to electing the Vice-Presidents as provided at present. Or, if it is thought best an amendment could be adopted providing that when the First Vice-President is elected that he will serve in that capacity for one year and then advance to the presidency without further election.

In this connection, there is a constitutional provision against any member of the House of Delegates being elected as President or a Vice-President and in the event that there is provision made for a President-elect the same regulation should apply to this office. Further, the Trustees are members of the House of Delegates, but without the privilege of voting. I do not believe that this restriction should apply to them and if there is any question about it I would recommend that the provision relating to this restriction be amended to read. "No voting member of the House of Delegates shall be eligible to the office of President or Vice-President."

The office of Trustee should call for our best men and I do not believe that it is entirely just to make it impossible for a Trustee to be elected President, President-elect or Vice-President.

Deceased Members.

During the past year a number of our members have been called to their reward, notable among these are two ex-presidents: Dr. Henry A. Smith, Cincinnati, Ohio, who served as President of the American Dental Association in 1881, and Dr. V. E. Turner, Raleigh, N. C., who served as President of the National Dental Association in 1908. Your president, in behalf of the Association, sent appropriate messages to the bereaved families. In addition to these Dr. M. H. Fletcher, Cincinnati, Ohio, an enthusiastic member

of the Research Commission died March 26th.

No doubt the Necrology Committee will present a report to the House of Delegates and it is suggested that anyone knowing of a deceased member should give this information to some member of the committee.

President's Address.

In order to simplify our work and to permit the members of the House of Delegates to be better informed of its contents and recommendations, I suggest that hereafter the President's Address be printed in advance and ready for distribution to the members of the House of Delegates immediately following its presentation.

Finally, dependable conclusions should be reached only after a thorough study of the meritorious points of the questions under consideration and when approved by our Association they should receive the loyal support of all.

We fully appreciate that this year has probably been the most critical in the history of organized dentistry and that some may differ from the policies of this administration, but in returning to the ranks I have the consciousness of having consistently and imparitally labored without fear or favor for what seemed to me to be for the best interests of a great and representative National Dental Association.

For the convenience of the committee of the House of Delegates, to whom this address will be referred, I herewith recapitulate my recommendations:

To express approval of the purposes of the American School Hygiene Association and the Race Betterment Congress and appointment of delegates to these meetings.

To authorize future Presidents to appoint delegates to such meetings as he thinks best.

That state societies amend their constitution and by-laws in order that the membership in these and the National may be more in harmony.

Plans for National Dental Journal.

Increase in Educational Standards.

Resolution disapproving Low dental patent.

Telegram to Senator Pomerene regarding H. R. No. 6282.

Committees selected so that it is possible to get together without too much travel.

Legislative Committee to be within easy access of Washington.

Army and Navy Dental Corps legislation.

Liability Insurance and continuing of Law Committee.

Combine Oral Hygiene and Public Dental Education Committees into one standing Committee.

Text book on Oral Hygiene.

Provision for general conference committee authorized to confer and co-operate with various allied organizations.

Appointment of standing committees.

Reducing the delegates from states where two societies are recognized.

Election of President-elect or First Vice-President.

Making Trustees eligible to office.

Printing of President's Address.

That the proceedings of the 1914 meeting of the Southern Branch be included in whatever form our proceedings are published.

Eliminate Art. 8 of the constitution.

Eliminate Book I, Book II, Book III, Book IV and Book V in by-laws.

Only members and guests to be admitted to sessions and clinics.

Strike out the first sentence in Section 3 of Chapter IV of the by-laws.

THE FUNCTIONS OF DENTISTRY AND MEDICINE IN RACE BETTERMENT

By Victor C. Vaughan, M. D., Ann Arbor, Mich., President of the American Medical Association

(Oration delivered before National Dental Association at its Eighteenth Annual Meeting, Rochester, N. Y., July 7, 1914.)

I BRING you greetings of fraternal love and respect from the American Medical Association which has recently held a most successful session at Atlantic City.

The ultimate goal set by the two professions is the same. The roads we travel lie side by side, and our destination is the same. Our common purpose is to dig from the mines of science the rich ores of health and happiness, and to transport and distribute these products among the people of this broad land. Whatever the business outlook in commercial matters may be, there never has been a time in the history of the world when the dentist and the physician has so much to do, nor has there been a time when this work was of so much importance to mankind. Our laboratories and clinics are offering day by day rich discoveries; the public appreciates their worth as it has never done before, and it is our function to supply the demand.

Preventive medicine, a large part of which is dentistry, is proving to be a most potent factor in the uplift and betterment of mankind. The public recognizes this function, and is not only willing to accept aid from the physicians and dentists, but is demanding help. Full and cheerful response to this demand gives our professions opportunity to do a patriotic work which has come to no group of men in any country at any time. Improved methods of transportation have brought the most distant parts of the earth into close relationship. The plague of the fifth century in the reign of Justinian needed a century to travel from Constantinople to London, and the small pox was nearly a thousand years in its journey from China to England.

Ancient students recognized the fact that epidemics almost universally spread from east to west, and the earliest writings on epidemology gives this as an established fact, but they failed to see that this was due to the general movement of mankind in the same direction. Now, the plague in Manchuria and India is within a few days of our shores. Disease now travels by steam, and I suppose that in another generation it will be making aerial flights. The commerce of today could not exist without preventive medicine, and the lapse of sanitary regulations for a month would devastate the world with a pestilence such as shrouded the race in the darkness of the Middle Ages.

Today the Bubonic Plague insidiously has worked its way into New Orleans, and the application of the results of scientific discovery is the only possible procedure that can save this country from its spread. Indeed, the civilized world depends upon preventive medicine to check the spread of epidemic diseases, and it looks forward to the time when pestilence will be wholly eradicated. Dentistry and medicine can grow

and increase in helpfulness to mankind only as scientific investigation develops and advances. Medicine in its broad sense consists in the application of scientific discovery to the prevention and cure of disease. The ultimate goal of scientific medicine is the domination of all the forces of nature and their utilization in the improvement of the races. It is the uniform testimony of historians who have described the effects of epidemics, that in the presence of pestilence man tends to lapse into barbarism. It is said that practically every retrogression in morality has been accompanied by, or has been due to disease.

On the other hand, the historian shows that under salubrious conditions man grows not only in bodily strength, but in mentality and morality. In the Modle Ages the average life was less than twenty years. Now it is quite fifty years, and it might easily be increased by fifteen years if the people as a whole make strict application of the facts already demonstrated by studies in preventive medicine. Not only has life been lengthened, but the efficiency of the individual has been multiplied, and there seems to be no limit to the good work that is possible in this direction.

Within the past few years the dentist has demonstrated the great value of his services in the improvement of the race. The mouth as the most important port of entry for infection needs most skillful, hygienic supervision. This work can be done only by the skilled, scientifically trained, dentist. The public has shown its recognition and appreciation of the work of the dentist. School inspection is growing year by year, and no thoroughly up-to-date school building is now planned without provision for the dentist and his work. One or more decayed teeth, with consequent infection, so impair the vitality of the child that physical and intellectual development is impossible. Thus weakened, such a child becomes a dullard in school, and when adult life is reached he is found as a member of the defective class, and becomes a burden, possibly a danger, to the community in which he lives. Relieved in early life of this impairment, the child is likely to grow into a self supporting, self-respecting man, endowed with intelligence and capable of contributing more or less to the common welfare. In short, a defective machine has been set in order and now works efficiently.

Deformities of the jaws and mal-positions of the teeth interfere with the proper development and functions of the brain, and I know of no more important work done in any branch of science than that now being directed by your research committee. It seems a miracle to convert the stupid dunce, incapable of the simplest forms of mental activity, into the wide-awake, alert, energetic youth. Yet this is what you have done by modern dentistry as embodied in you, gentlemen of this association. No one can do less than speak his high appreciation of the services you are rendering your country and your kind. You should be given every possible facility in the prosecution of your labors, for you are hastening the day when the superman shall be born and intelligence shall rule the earth. I believe that the best of the race have been so improved by evolution that man has reached a stage when he becomes a conscious co-worker with his Creator in the betterment of our kind, and that the future of the race is largely in man's keeping and under his direction. God speed you in your good work.

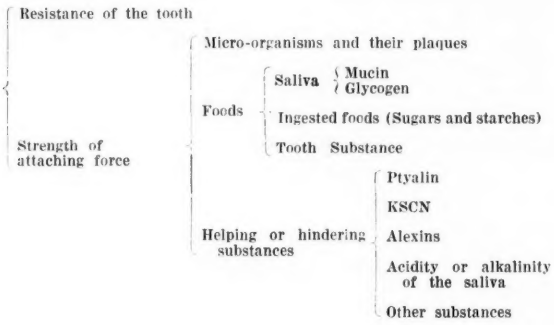
DENTAL CARIES

By Russell W. Bunting, D. D. S., and U. G. Rickert, B. S., M. A.

(Being a report of the work done upon this subject in the laboratories of the University of Michigan, under the auspices of the Research Commission of the National Dental Association. Read before National Dental Association at its Eighteenth Annual Meeting, Rochester, N. Y., July 7-10, 1914.)

OUR work of the past year has been of a general nature, in which we have endeavored to cover the entire scope of the problem of dental caries. We have adopted this plan in order that Mr. Rickert might obtain a comprehensive view of the various factors which have a direct bearing upon the question under consideration, and also that we might decide more intelligently as to the direction along which our future studies should be pursued. It has been our endeavor in making this report to give a general survey of the problem, and to link up our own observations with those of our contemporaries, in order that the various facts may be seen in their true bearing and in the light of present knowledge.

A general view of the various factors which are directly concerned in the process of dental caries may be graphically shown by the above diagram.



RESISTANCE OF THE TOOTH.

That caries of the teeth is largely dependent upon the character and quality of the teeth has in all ages found a wide acceptance. Many have claimed that from clinical data there could be no doubt but that the so-called "soft" teeth were more liable to caries than those of a harder and more perfect variety. The susceptibility of such teeth was attributed to a deficiency in amount and organization of their inorganic constituents. Several observers have made investigations in the attempt to gain some definite information in this regard. Among the results which have been obtained, is the work of G. V. Black*, who in the compilation of a large number of analyses of teeth came to the following conclusions: "No diminution of density or percentage of lime salts occurs in the teeth of women during the process of

*Dental Cosmos, Vol. 37, page 353.

child-bearing because of that fact. Any basis for accounting for caries in this or that case on account of 'frail teeth' or 'teeth below the medium in structure,' 'poorly calcified teeth,' etc., must disappear." This later statement he based upon the fact that the specific gravity and lime salt content of carious teeth was equal to that of immune teeth.

In this regard W. D. Miller stated* that his observations lead him to the view that "the enamel of different persons, as well as the different teeth of the same person and different parts of the same teeth, does show difference in resistance to acid; likewise the thickness of the enamel cap as well as the integrity of the enamel surface, freedom from fissures, bruises, cracks, weak lines of imperfect calcification of prisms, etc., as far as these come within the sphere of infection * * * * * * * the resistance of the enamel is only one of the factors (of caries) and its import will be found to vary greatly in different cases."

H. P. Pickerill, in his work on dental caries**, has done much to show the variance in enamel surface of teeth in a graphic manner. He succeeded in rubbing graphite and silver nitrate into the surface of the enamel and demonstrated that the permeation of certain forms of "soft" teeth was much greater than that of the hard varieties. In his conclusion he states, "That these departures from the normal structure are potent factors in lessening the resistance of the teeth to caries cannot be doubted. They must favor considerately the retention of foodstuff and micro-organisms; they expose a larger and more vulnerable surface to the action of the acid produced; they negative both mechanical and physiological prophylactic measures; and the fissures which have been described, since they allow of the penetration of silver nitrate and graphite, must permit the penetration of lactic acid, if not of carbohydrates. In fact *ceteris paribus*, it may be quite logically inferred that the amount of graphite which an enamel surface retains is a measure of the amount of food stuff it would tend to retain, and a demonstration of the situations of its retention. Added to which is the demonstrable fact that teeth so affected are not infrequently likewise the subject of caries."

In addition to these we have the writings of Boedecker, Caush, Von Abner, Fleischmann, Von Beust, Baumgartner, and many others who believe that the dentin and enamel are capable of change in structure and density due to an internal metabolism. Also those of Erdheim who has found that rats from which the parathyroids have been removed have poorly formed enamel. From all of these writings we see that there are many who hold that the susceptibility of the teeth to caries is largely determined by the perfection of the formation of the teeth, and that changes in the susceptibility may be due to changes in the enamel and dentin as the result of internal and nutritional causes.

In the light of our present knowledge there can be little doubt but that certain teeth are more susceptible to caries than others. In spite of the fact that the percentages of lime salts in such teeth do not vary perceptibly from the normal, it seems very evident that the manner of organization of the various enamels and dentins may determine to a certain extent their permeability and solubility. In addition to this, the degree of glaze upon the enamel surface, and the perfection of union of enamel surfaces in the sulci of teeth is a large factor in the determination of the amount of food stuffs retained in its immediate vicinity. But although we may grant that the resistance of the tooth is a factor in the pro-

*Dental Cosmos, Vol. 47, page 30.

**Pickerill, Prevention of Dental Caries and Oral Sepsis.

cess of caries, the opinion that it is a predominating factor has not obtained general acceptance. We have so frequently seen teeth which were soft and imperfectly formed which, even in the stress periods of life of the individual, have suffered little from caries, and we have seen the strongest and best formed teeth in other individuals readily succumb to the ravages of caries. So that, recognizing the effect which the resistance of the teeth may have as a factor in dental caries, we are forced in our search for the determining causes, to turn to those factors which lie without the teeth as expressed in the attacking force.

THE BACTERIA AND THEIR PLAQUES.

Since the early work of Miller upon the causation of dental caries as stated in *Micro-organisms of the Human Mouth*, his hypothesis of destruction of the teeth by bacterial products has received almost universal corroboration and support. These studies of Miller, together with those of Goadby, Williams and Black, point very clearly to the fact that the acid of caries is not produced by any one specific organism but that it may be the product of several of the common mouth bacteria. There is, therefore, no specific organism of caries which is to be found in the mouths of susceptible individuals and is absent in the immunes. The same process of lactic acid formation occurs in both classes alike.

We may ask, however, whether or not the combined bacterial flora of one mouth may form acid more rapidly than another and thus predispose the teeth to caries. In this regard Miller makes the following statement*:

"The saliva of immunes developes in the presence of carbohydrates, in and out of the mouth, on an average of a little less acid than that of highly susceptible persons. The difference is, however, not constant and is not sufficiently marked to account for the marked difference of susceptibility."

In a former communication** we gave the results of fermentation tests carried out in selected salivas. In these one-half gram of bread was added to 10 ccm samples of salivas*** taken from six carious individuals and six immunes. The mixtures were incubated for 24 hours and the resultant acid estimated in terms of NaOH n-100 per ccm. The table appears as follows:

TABLE 1.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Immune	Ac. 2.75	Ac. 3.80	Ac. 3.00	Ac. 2.75	Ac. 3.40	Ac. 2.45
	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
Susceptibles	Ac. 3.00	Ac. 3.40	Ac. 3.90	Ac. 3.30	Ac. 3.30	Ac. 3.00

In this experiment but little difference is seen in the amounts of acid formed in the two classes of cases. As this method of determination may be interfered with by the variable amount of neutralization which may take place between the several salivas and the acid formed in them, we have attempted to check the rate of fermentation by the following method:

Saliva was collected from various patients, in sterile tubes. From these 10 ccm portions were taken by means of a sterile pipette and run into another sterile tube. Into this 10 ccm portion one-half ccm of a 10 per cent sterile sugar

*Dental Cosmos Vol. 45, Page 689.

**Dental Cosmos, Vol. 56, Page 290.

***The term saliva in this report refers to total salivary secretion collected under the stimulus of paraffin chewing.

solution was introduced, which therefore contained 50 mg. of glucose. Each of these samples were incubated for six hours, at the end of which time they were carefully titrated to estimate the amounts of glucose which remained. This was done by means of a modification of Purdy's method*.

This solution was further modified so that 2 ccm of it would be exactly reduced by 1 mg of glucose. This method was used in all of our sugar determination herein reported because of its adaptability to the detection of small quantities of sugar, and its sharp end point in such high dilutions.

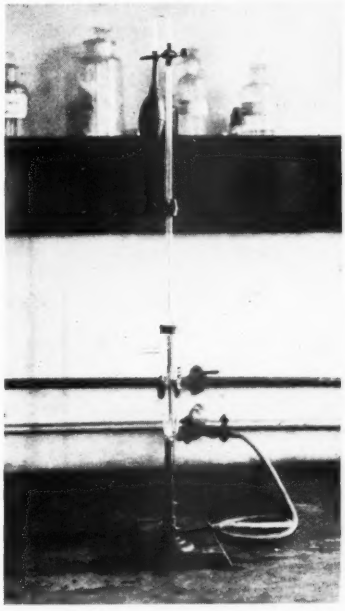
In the results which were obtained by this method it was found that there had occurred a variable amount of sugar consumption by fermentation. The amount of sugar disappearance varied from 10 mg to that of the whole amount introduced, 50 mg. Many cases showed a rate of sugar consumption when taken on several successive days which was fairly constant. The results obtained were checked with the condition of caries susceptibility of the individual from which the saliva was taken. The following table is characteristic of the data thus obtained:

TABLE 2.

Pregnant women	24 mg	18 mg	20 mg
Pregnant women	15 mg	18 mg	20 mg
Pregnant women	29 mg	40 mg	24 mg
Pregnant women	26 mg	30 mg	35 mg
Susceptible	24 mg	28 mg	30 mg
Immune	38 mg	39 mg	35 mg
Immune	42 mg	43 mg	45 mg
Immune	37 mg		

In these and in a large number of cases which were tested in this manner it could not be seen that there was any relation between the sugar consumption of the salivary bacteria and susceptibility to caries. We noticed that the rate of fermentation was dependent upon the oral hygiene to a certain extent. Two samples of saliva collected from the same mouth, one before and the other after brushing the teeth with clear water alone, showed a fermentation of the former which was twice that of the latter. So, also, was the fermentation high in those salivas which were collected in the morning before the mouth had been cleansed.

Fig. 1



(Apparatus for estimating carbohydrates in saliva.)

In view of the data thus obtained, we can but conclude that the bacterial flora and their ability to ferment carbohydrates, varies in different individuals, as well as in the same individual and that this rate of fermentation bears no apparent relation to the caries susceptibility.

*Purdy's method of sugar determination is a modification of the classical Fehling's test. It consists of one solution having the following formula:

Copper sulphate	4.75 gm.
Potassium hydroxide	23.5 gm.
Ammonia U. S. P. Sp. Gr.	.09 350 ccm.
Glycerol	38 ccm.
Distilled water up to	1000 ccm.

Very early in the study of caries it was seen that in many instances the process took place beneath or in connection with a thin film or plaque. Although its presence has been well demonstrated, still by reason of its thinness and transparency the plaque has resisted the efforts put forth in endeavor to determine its composition and the method of its formation. It has been spoken of as "gelatinous," "glutin-like," "zooglea," "mucinous," etc., by various observers and has been considered by many to be the product of bacteria thrown up for their own protection. Kirk* has suggested that the plaque may be formed by the precipitation of the mucin by lactic acid produced by fermentation. Thus, bacterial action in its production of acid would determine the formation of a mucinous covering over the organisms and their products. Miller**, Williams, and others have shown sections in which a distinct plaque is present without caries, and conversely, cases of caries in which no plaque can be demonstrated. The trend of the writings of Williams and Black have been toward the opinion that the plaque exercises the property of a protective and confining agent toward the bacteria and their products, thus favoring and making possible the process of caries. On the other hand Miller*** believed that in some cases the plaque is a protective agent to the tooth covering over the enamel and resisting the action of acids, whether of general or specific nature.

There are several principles in the process of caries which point quite definitely to the importance of the so-called plaque. We know that unless there be some form of protection of the bacteria against displacement by the action of mastication, and of the acids which they produce against dilution and neutralization by the saliva, the tooth would not be decalcified in the process of caries. The bacteria must be protected and the acids which they form must be confined against the tooth. This may of course be accomplished by the packing of carbohydrate food into protected and out-of-the-way places where the bacteria may thrive and produce their acids undisturbed. But many cases are seen in which there is every evidence that the protection has been accomplished by a very thin substance, which is transparent and colloidal in its nature.

On the other hand we very commonly see cases in which the teeth are completely covered with coatings and films which are thick enough to give them a greasy appearance and at the same time little or no caries has taken place. All of which can only lead us to the conclusion that the plaques and films which form upon the teeth are not all of the same character in their composition or in their effect upon the teeth and caries. It seems very evident that some forms of plaques which occur in certain mouths have the property of favoring caries and making it possible, while in other classes of cases films are formed which are protective in their nature, and which do not favor acid fermentation in their substance.

As to the character of the plaques or the differences in their composition we have little information. It has been thought that they formed more readily in some mouths than in others and that they were more likely to collect upon the rough than the smooth enamel surfaces. For the purpose of obtaining information in this regard we have grown plaques or films on glass slides from the salivas of various individuals. These were grown in test tubes which contained glass slips, which were bathed in saliva. The tubes were incubated at body temperature and the saliva changed every twenty-four

*Dental Cosmos, Vol. 52, Page 729.

**Dental Cosmos, Vol. 46, Page 993.

***Ibid.

hours. The glass slides which were used were ordinary microscopical slides slit lengthwise to make them one-half their regular width. Two such slides were placed in each tube, the slides being held in contact at their upper end and separated at the lower by the thickness of a bit of glass of similar weight. In this manner the slides had a V shaped space between their two inner surfaces which to a certain extent simulated the interproximal space. The inner surface of one glass was roughened with a carborundum wheel, by which the glaze was removed from a small area. These glass slips, when placed in their test tubes and sterilized, were covered over about three-quarters of their surface with saliva. They were then incubated and the saliva changed daily. The same saliva was used in each case, and at the time the saliva was changed the tubes and slips were washed with sterile water. We found that in every case a film or coating was formed. This began to appear first at the meniscus of the saliva and gradually worked down over both surfaces of each glass. In some cases the growth was more rapid on the inner surface of the glass and in others the outer surface had the greatest collection. We could detect no difference between the amount of growth or its adherence upon the rough portions of glass over that of the smooth places. There was, however, a considerable difference of rate in the formation seen in different salivas. In many cases a thick adherent growth would be formed in twenty-four hours which could not be washed off by the force of rapidly running tap water, while others formed a flocculent percitate, which did not readily stick to the glass and was slow of formation. When these films were stained with bacterial stains it was found that they unfortunately did not take the stain well. It seemed to be difficult to get the stain to penetrate the colloidal substance which enveloped the bacteria. It was possible in many cases to see that one form or another of the mouth bacteria was growing in predominence, and in case of the fast growing adherent films, their points of attachment seemed to be about small compact colonies of micrococci. We met with one case in which there was a very rapid growing white plaque formation in which the predominating organism was a large oval body which had the characteristics of a yeast. The saliva was taken from a pregnant woman whose teeth were being destroyed by caries with great rapidity and were covered with a white pasty film. This organism could be picked from her saliva at any time or from the patches about her teeth. When grown upon glucose beef tea it would produce acid very rapidly. It refused, however, to grow upon any other saliva than that from which it was taken.

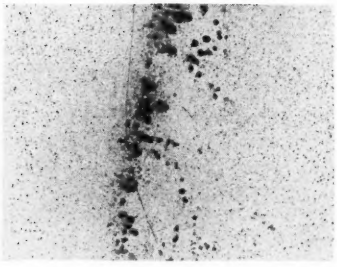
The results of our studies lead us to the conclusion that films or colloidal coatings are formed upon all teeth; that these films differ widely in character; and that they play an important part in the chain of factors which by their balance determine the process of caries. We feel that more study should be put upon them in the endeavor to ascertain their exact nature and the conditions which determine their character.

SALIVARY CARBOHYDRATES.

Since the ability of the bacteria of caries to form acid is dependent upon the supply of carbohydrate food, the process of caries is directly dependent upon the amount of available carbohydrate, which may be presented for bacterial consumption. Of the several sources from which this form of food might be supplied, the one, ever present agent is the saliva. The possibility of the presence of fermentable carbohydrate in the saliva has been a question of debate, and much has been written for and against its importance. Micheals, of Paris, claimed* that the salivas of many

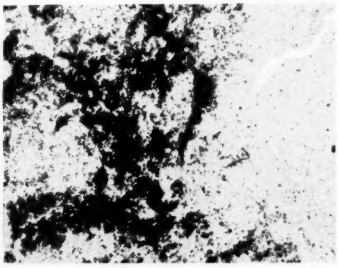
*Sialo-semiology, International Dental Congress 1900.

Fig. 2



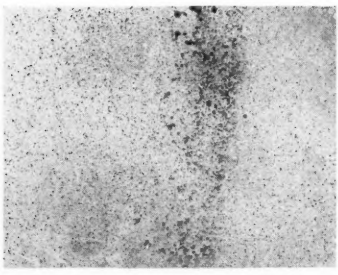
Salivary Film 20 x. Twenty-four Hours' Growth.

Fig. 5.



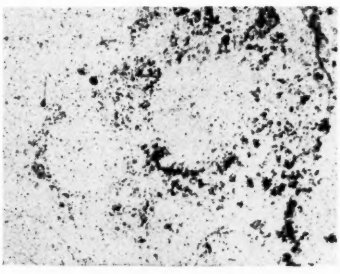
Salivary Film 20 x. Twenty-four Hours' Growth.

Fig. 3



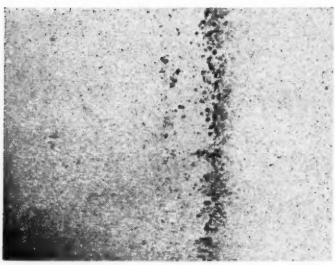
Salivary Film 20 x. Twenty-four Hours' Growth.

Fig. 6



Salivary Film 20 x. Four Days' Growth.

Fig. 4



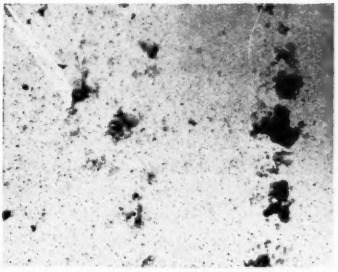
Salivary Film 20 x. Twenty-four Hours' Growth.

Fig. 7

Salivary Film 20 x. One Week's Growth.

susceptible individuals contained a fermentable carbohydrate in the form of glycogen. Glycogen, as we know, is a product of the carbohydrate metabolism, formed in the liver and given to the blood in small and definite percentages. He claimed that in excessive carbohydrate consumption, when the surplus of glycogen formed is being stored in the tissues it is also secreted in the saliva. In regard to this statement Miller published* a series of experiments and gave as his conclusion that "no fermentable substance of the group of carbohydrates

Fig. 8.



Salivary Film 20 x. One Week's Growth.

occurs in the salivas in sufficient amount to materially influence the progress of caries." At a later time he states** in a discussion of Lohman's*** mucin theory that an acid fermentation of mucin may take place. To this, he believed, may be accredited the cervical caries which occurs in connection with certain forms of abnormal buccal mucus, but that further work should be put upon the question.

Very recently Kirk**** has restated the proposition and has given as his opinion

*Dental Cosmos, Vol. 49, page 989.

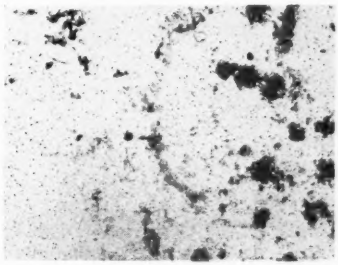
**Dental Cosmos, Vol. 47, Page 1293.

***Dental Cosmos, Vol. 46, Page 1086.

****Dental Cosmos, Vol. 56, Page 1.

that the carbohydrate content of the saliva is a variable factor and is of great importance to the process of caries. He has attempted to correlate the peri-

Fig. 9

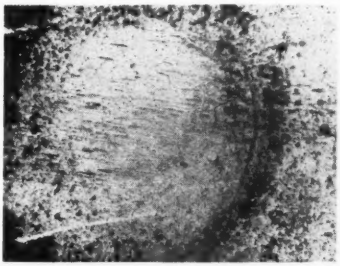


Salivary Film 20 x. One Week's Growth.

ods of caries susceptibility with that of the stress periods in life in which, by the effect upon the internal secretions, the sugar content of the blood, and of the saliva, may be increased.

All of this has led us to make an in-

Fig. 10.



Salivary Film 20 x. Four Weeks' Growth.

vestigation of the carbohydrate content of the saliva for the purpose of determining its amount and character. In a former communication* we gave the re-

*Dental Cosmos, Vol. 56, Page 287

sults of work done upon the fermentation of saliva. The table given reads as follows:

TABLE 3.

Immune .....Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Normal saliva .....Al. 0.23	Al 0.45	Al. 0.45	Ac. 0.20	Ac. 0.10	Al. 0.05
Incubated saliva.....Ac. 0.20	Neutral	Ac. 0.30	Ac. 0.30	Ac. 0.44	Ac. 0.40
Suscept. .....Case 7	Case 8	Case 9	Case 10	Case 11	Case 12
Normal saliva .....Al. 0.20	Neutral	Neutral	Ac. 0.19	Neutral	Al. 0.15
Incubated saliva .....Ac. 0.50	Ac. 0.52	Ac. 0.20	Ac. 0.90	Ac. 0.45	Ac. 0.50

Fermentation of clear saliva for 24 hours, the acid formed given as equivalent of HCL n-100, per ccm.

From this it will be seen that a variable quantity of acid will be formed from the fermentation of clear saliva. The strength may reach the equivalent of n-100 HCL or stronger in twenty-four hours. It will be seen also that the results do not bear any relation to the caries susceptibility. It must be remembered that the results given are the total amounts of free and uncombined acid present in the various salivas at the end of a twenty-four hour incubation. They are, therefore, not the measure of the total amount of acid formed, a portion of which had undoubtedly united with the alkaline constituents of their respective salivas.

The search of the saliva for sugar in the free state has resulted in a negative test in all cases. No one has demonstrated it in any case of saliva free from food debris, with the exception of a few cases of advanced diabetes. We have tested a large number of salivas with the most delicate reagents for sugars but were unable to detect an appreciable quantity, even in several cases of severe glycosuria. However, when we subject salivas to the a-napthol test, which is sensitive to carbohydrates in whatever form they may be present, we invariably get a positive reaction. From this we may infer that carbohydrates are present in the saliva, but that they are either in the form of a polysaccharide or non-reducing carbohydrate such as glycogen, or that they are combined with protein molecules in the form of glucoprotein, such as mucin. As to the first of these there is little evidence that glycogen occurs in any considerable, or even demonstrable quantity in the saliva. The second, mucin, is present in all salivas in variable amounts and should be considered. Hammarsten* says that mucin, when split by hydrolytic cleavage yields an amino-sugar which is glucosamin. This cleavage may be obtained by superheated steam, by which an animal gum is obtained, or by boiling with weak acids or strong alkalis, in which case a reducing substance is obtained.

In our attempt to obtain, if possible, all the contained carbohydrate material of various salivas in a form in which they might be determined quantatively, we have adopted the following method. Ten cubic centimetre samples of each saliva are placed in test tubes and two drops of a concentrated HCl solution added to each. The tubes are then sealed in a flame, and placed in an autoclave, in which they are subjected to 100 lbs. pressure for thirty minutes. The amount of carbohydrate in each is then estimated by the modification of Purdy's method given above, the resultant figures being in terms of glucose. We have tested a large number of salivas in this manner and have found a variable quantity of

*Physiological Chemistry—Hammarsten 1908, Page 65.

carbohydrate in practically all salivas. The estimated amounts are, however, in all cases, exceedingly small. They vary from 0 to 1 mg per ccm. The average saliva gives a reading of 0.4 mg to 0.6 mg, but none were found that went above 1 mg per ccm. The readings obtained were fairly constant from day to day in the same saliva, but those of salivas collected before breakfast were slightly higher than those taken later in the day. The slight variations which appear in the various salivas follow very closely the variations in the mucin content of the respective salivas, and lead us to the opinion that the total carbohydrate content of the saliva is practically confined to the mucin which it contains. The amounts obtained bear no relation to the caries susceptibility of the individual from which the saliva is taken. We questioned whether the bacteria were able to break up these glucoproteins, and cause the fermentation of the carbohydrate contained. In this regard Hammarsten says* "The glucosamin, so far as we know, is not split off by proteolytic enzymes, but only after strong hydrolysis with acids."

In view of this we incubated a second sample of a large number of salivas and then subjected them to the acid, temperature and pressure. In practically every case the carbohydrate had disappeared at the end of three hours incubation. In this experiment we cannot say definitely that the bacteria, during incubation, break up the glucoprotein molecule, and ferment the carbohydrate molecule set free with a resultant formation of acid. We know, too well, that there may be any number of directions in which these compounds may be split and it is always difficult to say just what the result of such a process may be. We can but say in this regard that there is an indication that the glucoprotein may be split up by bacterial action and that subsequently the carbohydrate thus obtained may be fermented to form acid.

Any conclusion which we may draw from these results must presuppose that we have by this heroic treatment obtained the entire carbohydrate content of the saliva in the form of reducing sugar and have secured an accurate quantative record by the method employed. Taking the results as they stand, having made them with the greatest care, we can but conclude that there is a minute variable amount of carbohydrate in the average saliva; that this carbohydrate exists chiefly in the form of mucin; that from the work done no relation can be seen between the amount of carbohydrate and caries susceptibility; and that the amount of salivary carbohydrate is so small in comparison with the ingested carbohydrates, the largest not exceeding one gram per litre, that we can see little evidence in support of the importance which has been given to its relation to dental caries.

INGESTED FOODS.

A large and important source of carbohydrates for fermentation is to be found in the daily consumption of foods a portion of which may be retained about the teeth. The amount of such food which will be retained is dependent upon three factors: 1, the character of the food ingested; 2 the character and function of the teeth; 3, the character of the saliva.

As to the nature of the foods, it is very evident that certain forms of carbohydrates have a greater tendency to stick to the teeth than others. The soft sticky varieties of sugars and cooked starches which are slowly soluble, are especially liable to retention, and form favorable pabulum for acid fermentation. That the continued and copious diet of such substances is favorable to caries, cannot be doubted. The mouths of candymakers, millers, and children who eat largely of sweets are strong in the corroboration of this view. And conversely we know that

*Ib'd, Page 67.

the Esquimeaux and the meat eating tribes of Central America, who have little or no carbohydrate in their diet, are as a race, remarkably free from caries.

The amount of food stuffs which are retained about the teeth is in direct relation to the character and function of the masticatory apparatus. In case the dental arch is composed of well formed and well placed teeth, all of which are in good occlusion with their antagonists, the food may be finely divided, and finding no favorable place for lodgment, it will be washed out of the mouth and swallowed. Such a set of teeth may be said to be "self-cleansing." On the other hand, the poorly formed teeth, and teeth which are irregularly arranged and in abnormal occlusion, tend to offer retention for food-stuffs, and are less likely to be self-cleansing. In the irregular spaces between such teeth, in flat interproximal spaces, and in wedge, or V shaped areas formed by the overlapping of teeth, food will be wedged and retained until it has been removed mechanically or destroyed by bacterial action.

And in addition to these forces, the nature of the saliva exercises a marked influence upon the retention of foods. Certain salivas are of a viscous nature which tend to stick food materials to the teeth, and produce an unhygienic condition of the mouth. This sticky and mucinous saliva diminishes greatly the self-cleansing factors of the mouth, and it is with great difficulty that such a mouth can be kept clean. Another factor bearing upon this phase of the question is that of the ptyalin of the saliva. As will be discussed further along, we know that the ptyalin exerts a powerful influence in the cleansing of the mouth, by its action of reducing the insoluble and sticky starches to soluble sugars which are readily washed away by the saliva. This may be seen in the average mouth by testing the brushings from between the teeth, 15 to 30 minutes after eating carbohydrates. The result will usually be negative to Fehling's test. The saliva, therefore, by its physical and bio-chemical action, forms a distinct and important force in the process of self-cleansing of the mouth.

In recent years the studies and writings of Wallace*, Pickerill**, and Gies***, have looked toward the changing of the character of the salivary secretions from that which tends toward food retention to that which will favor food elimination. The method which they suggest is that of increasing the fruit acids in the daily diet, making them an important part of every meal, and of the use of organic acids as a mouth wash and mouth cleanser. They are practically agreed that such a diet will increase the flow of saliva, raise its alkalinity, and increase its detergent properties. They, therefore, advocate the general adoption of such an acid diet for the purpose of rendering the mouth hygiene more perfect, and for the reduction of the acid properties of the saliva. This view is corroborated by the work of Pawlow****, and which has been summarized by Hammarsten***** as follows:

"The quantity and composition of the mucin glands is greatly dependent in dogs upon the physical excitement, but also upon the kind of substances introduced into the mouth, and an adaptation of the glands for various mechanical and chemical irritants is found to occur. Under the influence of hard and dry food the glands secrete abundance of saliva, while with food rich in water the secretion is considerably less and accommodates itself according to the quantity of water in the food. Milk is an exception

*Supplementary Essays on the Cause and Prevention of Dental Caries 1906.

**Prevention of Dental Caries and Oral Sepsis 1912.

***A Further Study of Dental Caries, Jour. of Allied Dental Soc., Vol 8, Page 283.

****Arch. internation de Ph., siol, 1, 1904.

*****Ibid, Page 342.

to this rule as it causes a more abundant secretion of saliva than meat. This is of importance in the digestion of milk, as in the stomach the mixture of milk and saliva does not coagulate to a compact mass but separates to a finely divided, readily digestible condition. By the action of strong chemical bodies the saliva is secreted in proportion to the strength of the irritant. The irritants are thereby diluted and washed out at the same time. *The partaking of acids brings about the secretion of a thin saliva, poor in mucin, in quantities sufficient to neutralize the acid, while on the introduction of food the glands secrete a saliva rich in mucin and diastatic enzymes.*"

In accordance with this suggestion we have recommended to many carious succeptible individuals, and those whose saliva was viscous and mucinous in nature, that they adopt this distinctly acid diet. In cases in which it was difficult for them to conform to the class of food suggested, cream of tartar, acid potassium tartrate, was prescribed, one teaspoonful in water, tid. at meal times. As a result of this treatment a number of cases showed a marked improvement. The teeth were more easily kept clean, and they took on a clean shiney appearance. There were, however, other cases in which no change appeared in the saliva or the mouth conditions. There were a number of others in which disagreeable symptoms of a general nature resulted, which necessitated the discontinuance of the treatment. Digestive disturbances and exanthematous rash were very severe in these cases, the patients giving a history of compulsory abstainence from all acid diet for many years.

The suggestion of the use of potassium acid tartrate by Pickerill, and of vinegar by Gies for a mouth wash is contrary to many preconceived ideas. We have been in the habit of prescribing and using alkaline washes, with the idea they would dissolve the mucins of the mouth, for which they are a solvent, and would neutralize any acid which might be present. Gies says that the vinegar will precipitate the mucin in a coagulated form which will easily be washed away by the copious flow of alkaline saliva. As a test of the efficiency of vinegar as compared with that of weak alkalis such as sodium carbonate and borax we carried out the following experiment. Films were grown on glass slides in test tubes, by the method described above. Each day, at the time of changing the salivas, the glasses were washed by one of the solutions to be tested, with the view of determining the one which had the greatest solvent action upon the films formed. By this method it was found that the vinegar had a greater dissolving and detegent action than did any of the alkalis in strengths tolerable to the mouth tissues, and also more than that of a saturated solution of potassium acid tartrate. From our experience with the vinegar method of oral prophylaxis, we can but agree with the statement of Gies as to its efficiency but his claim that vinegar is entirely harmless to the teeth we are not *as yet* prepared to accept. There are many cases of thick mucinous salivas, in which the teeth are continually coated with colloidal substances, and in such cases the vinegar treatment would in all probability cause little damage to the enamel of the teeth. But in those cases of watery salivas, in which the teeth are habitually clean, many times extremely sensitive to the action of the weak acids, and suffering from labial and buccal erosion, in all such cases the vinegar treatment should be employed advisedly and with extreme caution. The average prophylaxis worker has in mind many such cases for whom he has found it necessary to prohibit the use of organic and fruit acids except in limited quantities. We feel that the suggestion made and the treatment outlined is a good and valuable one for certain cases. An intelligent use of the acid diet and acid washes will

change many filthy and unhygienic mouths to a cleanly and hygienic condition. But let us not make the mistake of looking upon this method as a universal panacea for all dental ills, and use it blindly in all cases. We should rather intelligently try it out upon those cases over which we have a control and take every precaution lest we fall into other and greater ills than that which we seek to prevent.

Although we can safely say that *as a rule* retained food stuffs of the nature of carbohydrates is favorable to and a potent force in, the process of caries, we cannot assume that it is always so. We are all familiar with the foul filthy mouth, in which food materials of all kinds are continually present about the teeth, and at the same time no caries has occurred. We can but conclude that the retention of food material may be a strong factor in favor of caries, but that it cannot be looked upon as an all predominating influence. In all such cases where caries is evident, its progress will usually be impeded, and may even be stopped by the rigorous application of the principles of oral prophylaxis. The proper selection of food, the perfection of the form and arrangement of the teeth, with the view of making them self-cleansing, and the alteration of the saliva by dietetic measures will all have their effect upon the process of caries. These alone coupled with the strict enforcement of prophylactic measures of a mechanical nature will in many cases render the mouth immune to dental caries. They must therefore be looked upon as a large and important group of factors in the process under consideration.

FERMENTABLE SUBSTANCES IN THE TOOTH.

In addition to the substances which have already been considered as possible food products for bacterial action in the process of caries, there still remain the component parts of the tooth which may, in themselves, be available for acid fermentation. One of the earliest views upon this question is that of Milles and Underwood* who, in speaking of the process of caries, say that "The organic fibril upon which the organisms feed and in which they multiply are the scene of the manufacture of their characteristic acids, which in turn decalcify the matrix and discolor the whole mass."

In his latest paper **Kirk has called attention to the above statement and has accentuated it. He states that by reason of the fact that the bacteria penetrate the dentin pulp-ward, unless there were food for their life and progression to be found in the dentin itself, they would be acting contrary to the known biological laws. The trend of all living things is to advance in the direction of their food supply and not away from it. The fact that the bacteria has a tendency to travel inward, he states as an evidence that the bacteria find utilizable food in the substance of the dentin.

It has always been difficult to explain many phases of the caries process by the theory that the carbohydrates for acid fermentation of the teeth were brought into the cavity by an osmotic pressure, and that this is the only source of food supply for acid fermentation. As we examine microscopical sections of carious dentin, and see the depths to which individual strains of bacteria have penetrated into the substance of the tooth, and as we notice the distance at which the advance guard of the bacteria may have withdrawn from their base of supplies, the osmotic theory becomes more and more unsatisfactory. For this reason it seems much more rational to look upon the organic fibrils of the dentin as a source of food supply for these bacteria, and from which they may form acid products

*International Medical Congress 1881.

**Dental Cosmos, Vol. 56, Page 1.

to carry on the process of decalcification. This being the case, there must be then a wide variance in the amount of available food material in the various teeth which are attacked, and which should influence the progress of caries in each case. The sclerotic teeth in which there has been a more or less complete calcification of the dentinal tubuli, with an attendant atrophy of the organic fibrils, should offer a far less favorable field for caries than that of young teeth with open tubuli.

But however we may view the theoretical food value of the dentin and its effect upon the process of caries, we cannot look upon it as of any importance in the inception of caries. The enamel has practically no organic substance, and the acids which decalcify it must be formed from materials which are outside of the teeth. We can therefore safely say that as regards the enamel the tooth has no food value for the bacteria of caries, and that beginning caries is dependent upon external fermentative processes and acid formation. It then plays no part in the susceptibility of teeth to beginning caries.

PTYALIN.

In addition to the bacteria and the foods upon which they flourish, there are a number of factors which have a direct relation to caries in that they may help or hinder its progress Of these ptyalin may be mentioned because of the fact that it has the property of hydrolysing starch compounds to a form in which they may undergo lactic acid fermentation. It was asserted by Hinkins that ptyalin not only changes starches to sugars, but that it also forms lactic acid and in this manner produces caries without the aid of bacteria. In refutation of this theory Miller made an extended series of experiments and gave* as his conclusions that ptyalin acting upon caries never formed acid in sterile solutions.

In his book on caries* Pickerill makes some very significant statements regarding the action of ptyalin and its bearing upon the process of caries. We quote as follows: "Since maltose is probably more easily fermented by the mouth organisms alone than is starch, it will obviously be of advantage either to have no ptyalin at all present or to have a considerable amount, so that the organisms either shall not be aided in their work or that their pabulum shall be easily swept away. Moreover, the conversion from starch to maltose is not a simple process; erythro-dextrin and achroo-dextrin are intermediary products. Now the sticky, adhesive nature of dextrin is well known; and if the ptyalin be small in amount the conversion process will be a correspondingly slow one, and the dextrin formed will remain longer and so tend to bind the substance closer and more firmly to the teeth. Again, free organic acids destroy the diastatic action of ptyalin; if, then, when the starch is slowly and partially converted into maltose and dextrin, the organism incorporated in the mass forms free lactic acid, no further action of the ptyalin takes place and the starch is literally gummed to the teeth to be slowly but surely transformed into lactic and other acids. On the other hand, if the action of the ptyalin is much more rapid than that of the organisms, there will be a fair chance of all the starch being converted into maltose, and so carried away, provided there is adequate salivary secretion. * * * * It is therefore of advantage to have as large amount of ptyalin per minute present in the mouth as possible.

All of which serves to call our attentention to the importance of this variable constituent of the saliva to the deter-

*Dental Cosmos, Vol. 47, Page 1295.

*"The Prevention of Dental Caries and Oral Sepsis," Pickerill, Page 161.

mination of the process of caries. We have during the past year tested a number of cases as to the rapidity with which eaten starches will disappear from the mouth. We have found that many mouths will eliminate starch in but a few minutes, so that no trace of carbohydrate is remaining. In the case of our own salivas it was noticed that at the time of extreme fatigue no ptyalin could be demonstrated, and the elimination of starches was greatly reduced. Further work should be done along this line and the value of this factor should always be considered in the study of any specific case of caries susceptibility

POTASSIUM SULPHOCYANATE.

Of* all the tests which have been made in the saliva, in the search for the controlling principle of caries, perhaps the most spectacular is that of the reaction which occurs in most salivas when they are treated with ferric chloride. The color which results varies from a light straw through the various shades of amber to blood red. Whenever such a color reaction takes place it has been asserted that there is a variable quantity of sulphocyanate in combination with some base such as potassium, sodium, or ammonia, and is usually spoken of as potassium sulphocyanate.

The late Dr. Micheals, of Paris, was the first to call attention to the possible bearing of the KCNS upon the process of caries. He felt that when present in relatively large amounts it might have an inhibitive action upon the growth of the micro-organisms of caries. Some time later, Drs. Low, Waugh, and Beach, of Buffalo, entered upon an investigation of the KCNS content of the saliva and its relation to caries. In their publications they stated that they found the substance in the salivas of immunes, while in the salivas of susceptible individuals it was conspicuous by its absence. So certain were they of the efficacy of this salivary constituent that they urged all dentists to test the salivas of their patients with ferric chloride, and in case there was no reaction, advised that KCNS be administered in regular doses until it appeared in the saliva. The startling assertions which were made, and the enthusiasm of the writers stirred up a general interest in salivary analysis among the dentists throughout the land. Hundreds of practitioners made the simple test a daily routine of practice, testing the salivas of all patients and administering the drug wherever it seemed advisable. As a result of this, much valuable data was secured but it was soon found that the results of many careful and fair-minded men were not in accord with those of the original promoters. In the statistics thus obtained it was not evident that there was a relation between immunity and the presence of KCNS, nor that the administration of that compound produced an immunity to the carious process. In addition to this, the scientific investigations of Gies, Lathrop, Pickerill, and many others were decidedly against the theory as stated.

I began work upon this phase of the problem soon after it was first reported by Dr. Low and his conferrers. Tests were made upon students and patients in the infirmary using the method suggested for determining the KCNS in the saliva, and carefully tabulating the results. I soon found that my data did not check with the theory, there being so marked a discrepancy that I was unable to subscribe to the views of the men who had advanced it. I then became interested in the test which was suggested for these determinations, namely ferric chloride. It seemed very strange that when we used ferric chloride in the urine we called the substance which gave a red reaction, aceto-acetic acid, and when we used the same reagent in the saliva, and obtained a red color we

*The following treatise upon KCNS in the saliva, is taken from a paper read before the Academy of Stomatology of Philadelphia, March 24, 1914.

said that it was due to KCNS. In addition to this we know that there are almost an endless list of organic compounds, which in their various forms and combinations give a reaction with ferric chloride which is in many respects like that of KCNS. Every one who has made many such tests in the saliva, and has attempted to check up the colors produced with a series of standard ferric sulphocyanate strengths, knows how frequently he is puzzled by colors which are not of the same quality as the standard. They may have strength but the shade is different and has no equivalent in the standard. Some of this, it is true, may be attributed to the influence of the mucinous and colloid materials in the saliva, but we may well pause to ask ourselves the question, "Are we certain that this red color is due to KCNS"?

In my attempt to gain a little further information in this regard I made use of the well-known principle that ferric sulphocyanate is very soluble in ether, and attempted to transfer the red compound formed in the saliva upon the addition of ferric chloride, to an ether solution. As the KCNS is seldom found in the saliva in such strengths that it may be shaken directly from the saliva to a supernatant layer of ether, it was necessary to dry down the salivas for the purpose of concentration and having brought about the reaction in a minimum amount of water, ether was poured over and the solution stirred. In some cases the color came up into the ether very readily, giving a shade which was much darker than that which was originally seen in the water solution. But in other cases the ether was much lighter in color or refused to take any of the red tint seen in the water.

In the December Cosmos for 1910, I published the results of my observations, calling attention to the discrepancy in the two tests, and stating my opinion, that this was due to the fact that there occurred in some salivas substances other than KCNS, which were capable of reaction with ferric chloride.

About one year later the first criticism appeared in an article entitled "Potassium Sulphocyanate versus Diacetic Acid," by C. Franklin MacDonald.* In this he very dramatically calls attention to some very serious errors which had been made in my technic, stating that he had attempted to shake the ferric salt of KCNS in various concentrations from water to ether and found that he was unable to transfer the color in strengths of KCNS less than 0.0125 per cent. He also called attention to the red color which remained upon the dish after the ether had been poured off, citing it as a source of error.

In May, 1912, Dr. Gies read a paper before the New York State Society, in which he considered the relationship of Sulphocyanates to caries.** In this article he takes issue with my findings in no uncertain terms and summarily dismisses them as unworthy of consideration. In the first place he objects to my use of the term *Potassium* sulphocyanate, questioning as to whether the cyanates exist in the saliva in that form. He very kindly answers his own objection in the same paper in which he says, "*For the sake of convenience* it is often assumed that all sulphocyanate in the saliva exists there in the form of *potassium* sulphocyanate." He further objects to my practice of adding a drop or two of ferric chloride and water to the dried salivas previous to applying the ether, stating that in this manner the ferric sulphocyanate was dissociated, and being ionized it became insoluble in the ether. A little later he quotes at length from my paper as follows: "In discussing the supposed advantage of the proposed use of ether, Bunting says (regarding the effect of adding ether to the colored liquid of the *ordinary positive test)*: 'Ferric sulphocy-

*Cosmos 1912, Page 58.

**Dental Cosmos, Vol. 55, Page 40.

anate, in the *undissociated* state, is soluble in ether; the undissociated portion, therefore, passes for the greater part (?) into the ether, a fresh amount of the undissociated compound is formed (?) in the *aqueous* solution, and this also goes into the ether. When the equilibrium is finally established, *there is much more undissociated ferric sulphocyanate in the ether than there was (in undissociated form?) in the water solution (originally?)*'" All of which he severely questions, and says that the statements do not seem to be based upon experience. In this connection I might state that the above quotation from my paper, with the exception of the italics, exclamation points, question marks and bracketed portions which are Dr. Gies' may be found verbatim on page 585 of the second edition of Ostwald's inorganic chemistry, as translated by Findlay, from which the statement was taken. Dr. Gies goes on to state that he was unable to shake the red color from saliva to the supernatant ether, and objects to my suggestion that aceto-acetic acid may be present in some salivas.

A few months after the Gies report, there was issued a brocure containing the work which had been done in the laboratory of Dr. Gies by Dr. Max Kahn upon the sulphocyanates in the saliva. In this Dr. Kahn also takes up the ether test, and has most nearly followed the technic as suggested. He has made some valuable contributions to the subject, among which he has tried out a long list of substances, which upon addition to the saliva gave a red color with ferric chloride. The list of these is a follows: salicylic acid, phenol, antipyrin, phenacetin, neutral formates, acetates, and succinates, pyrogallic acid, pyrocatechol, creosote, resorcin, benzoates, and meconic acid. In his conclusions he states; 1, the ferric chloride colorimetric test for thiocyanates in the saliva is inexact and unreliable; 2, a negative result by the Bunting suction method is no evidence of the absence of the sulphocyanate in the saliva; 3, a positive result by the Bunting suction method is evidence of a comparatively large amount of sulphocyanate in the saliva; 4, various medicinal substances and chemical compounds that are the result of the decomposition of proteins and carbohydrates may, if excreted in the saliva, give a very marked red coloration when treated with ferric chloride, and thus convey the impression that the amount of sulphocyanate is very large.

The latest work of importance bearing upon the subject is the reference made in the work of Dr. Pickerill in his book upon dental caries*. He says in this connection, "I am not prepared to accept Dr. Bunting's theories.

"1. Is the etheral solution more reliable than the watery solution of potassium sulphocyanate? The following simple tests give the answer in the negative." He then gives a series of tests in which he attempts to shake ferric sulphocyanate from water to ether, and meeting with difficulty in doing so concludes that it cannot be done.

"2. Is the possible presence in the saliva of other substances which give the ferric chloride test serious source of error?" To this he also objects stating for his reasons that aceto-acetic acid does not occur in the saliva, and that it would be unlikely that any drugs might occur in the saliva which would confuse the reaction.

In all of this, I naturally have been very much interested. It has been curious to note, first the number of different interpretations which may be made of a seemingly clear statement, and second, the difficulties which might be encountered by those attempting the use of the technic suggested. I felt very confident that in my hands the method had been giving me trustworthy results, but in

*Prevention of Dental Caries and Oral Sepsis, Pickerill, page 171.

view of the experience of others, many of whom were learned and able chemists, it seemed worth while that I look further into the basic principles of this test with the view of standardizing the method and estimating its accuracy. With this in view I have spent some considerable time in the consideration of the problem, the results of which I have the honor of bringing to you this evening.

The original statement of my working technic reads as follows: "Pour 5 ccm. of saliva into a thin curved watch crystal of about three inches in diameter. Allow this to stand in the air or sunlight, or better still, set it on a slowly steaming water bath, until the saliva has dried to the dish. To this add one or two drops of water and one or two drops of ferric chloride and stir with the residue to make a thick paste. To this add 5ccm. of ether, and stir the paste thoroughly. When well mixed, hold the glass on a level with the eye and note the color of the solution." The objection of my critics are that they are unable to shake solutions of ferric sulphocyanate from water or salivary solutions to ether, they are unable by the drying process, to get all the color to come up into the ether, and that they were only able to carry out the test in solutions which contained a relatively high percentage of KCNS.

As a first step I attempted to standardize my reagents and records of reactions. For this purpose I made solutions of KCNS of graded strengths, ranging from 0.0001 per cent, to 5 per cent. Ten cubic centimetre samples of each were placed in test tubes, the tubes corked, and placed in their proper order in a test tube rack. To each was added one drop of concentrated HCl, and one drop of ferric chloride solution. The resultant colors were taken as standard in all future readings. The ferric chloride solution contained 25 per cent of anhydrous ferric chloride in a slightly acidulated water solution. The size of drop used was about 15 per ccm., and which has been used throughout the report unless otherwise specified. Instead of pure ether, as a solvent, we have made use of a mixture of amyl alcohol 5 parts, and ether 2 parts, according to a suggestion made by Stokes and Cain* in their determination of small quantities of iron. This mixture is a much better solvent of ferric sulphocyanate than ether alone.

Our first task was to determine some of the laws which govern the interchange of the red ferric sulphocyanate from water to ether. We began with the weakest strengths of KCNS, taking 10 ccm samples in test tubes, acidulating, and adding 1 drop ferric chloride. After the reaction had taken place 10 ccm of ether was poured over and the whole shaken. It was found that it was impossible to cause the ether to take up any of the red color in the weak solutions. The strength was gradually increased until 0.08 per cent was reached, when a slight trace of color was noticed in the ether. As the KCNS was increased in concentration a greater increase in the ether absorption took place. At 0.2 per cent the water and ether solutions were equal, and at 0.5 per cent the ether reading was equivalent to 1 per cent, being *stronger than it was originally in the water solution.* Going over the same procedure with alcohol and ether solution instead of the ether, it was found that the first trace of absorbed color could be seen in a solution which was 0.03 per cent. At 0.05 per cent the water and supernatant alcohol-ether solutions are nearly equal, while the 0.1 per cent gives a color to the alcohol and ether which is equivalent to a 5 per cent water solution. So also do the strengths above this give *stronger colors* to their alcohol-ether solutions *than was originally seen in the water solutions.*

There are a number of factors which

*On the Colorimetric Determination of Iron with Special Reference to Chemical Reagents, by Stokes and Cain, Journal of the American Chemical Soc., Vol. XXIX, Page 409.

may enter into this reaction which are confusing and not easy of comprehension. For instance, if too little of the ferric chloride solution be used, the alcohol-ether solution instead of taking up the color, decolorizes the whole solution and if more reagent be used the proper reaction takes place. Also, if a slight excess of acid be used, the red color in the alcohol-ether solution is entirely discharged. This has been explained by Stokes and Cain* as being due to the fact that isodisulphocyanic acid is formed which reduces the ferric salts to ferrous compounds which are colorless. A great many interesting phenomenon may be seen in the study of the transferrence of ferric sulphocyanate from water to ether solutions of which there is not time to consider in this paper. It is sufficient for our purpose to note that the *absorption by the ether depends upon the concentration of the ferric sulphocyanate, and that above certain concentrations the ether color reaction is stronger than that of the water.*

We then made a series of tests in which the various strengths of KCNS in water were dried down and brought up in alcohol and ether. In all of these, 5 ccm samples were evaporated in watch glasses, a *small* drop of ferric chloride stirred into the residue and 5 ccm alcohol-ether was poured over. After stirring the solution carefully, the alcohol-ether was poured off into a test tube, and the color compared with the standard colors. By careful technic a distinct color may be obtained from a solution which contains 0.0001 per cent KCNS. A few of the results obtained in the various strengths of concentration are as follows:

0.001	%	KCNS	—	0.003	%	in alcohol-ether	
0.002	"	"	—	0.005	"	"	"
0.003	"	"	—	0.007	"	"	"
0.005	"	"	—	0.01	"	"	"
0.008	"	"	—	0.02	"	"	"
0.01	"	"	—	0.03	"	"	"
0.02	"	"	—	0.08	"	"	"
0.03	"	"	—	1.00	"	"	"
0.05	"	"	—	5.00	"	"	"

*Ibid.

From this we may readily see that the colors obtained by the evaporation method and alcohol-ether solvent are from two to five or more times as strong as are formed in the corresponding water solutions.

In explanation of this phenomenon there are two pre-eminent factors which should be noted. As we have seen, the interchange of red color from water to ether solutions on shaking is dependent upon the concentration of the ferric sulphocyanate molecules in the water solution. We saw that weak solutions could not be thus transferred but all solutions having a concentration equal to, or above, 0.05 per cent could be extracted by alcohol-ether. If, however, we take a 5 ccm sample of the solution weaker than 0.05 per cent, evaporate it to dryness, and produce a reaction between the KCNS and ferric chloride in a small drop of water, we have concentrated our molecules of ferric sulphocyanate in solution about one hundred times. In this manner we can bring solutions containing 0.0005 per cent KCNS to have the same concentration as 0.05 per cent, and should be as readily absorbed by the alcohol-ether. Secondly; when we shake various solutions of ferric sulphocyanate from water to ether, there is always a variable amount of red color remaining in the water solution. But if on the contrary, we concentrate to the smallest possible volume capable of giving a complete reaction between the KCNS and ferric chloride, the ether solution, when poured over will completely dissolve the color from the water, leaving no red color behind. We have, therefore, in the concentration method brought about a condition in which all of the ferric sulphocyanate may be transferred to the ether solution, and as the color of this salt is more brilliant in ether than in water we have a resultant color several times stronger than that of the water solution, as is shown in the table given. All of which serves to show the fallacy of the

attempt of many investigators to check the method suggested by the process of shaking, as well as their condemnation of the method upon these grounds. We next began a series of experiments with the view of determining whether the same reaction could be brought about in salivary solutions of KCNS as were seen in the water. To this end a number of tests were made in the following manner. Two 5 ccm samples were taken of salivas which were negative to ferric chloride. To each of these ½ ccm of a 0.1 per cent. KCNS solution was added. One solution of each pair was dried on a watch crystal, two drops of ferric chloride solution were stirred in and 5 ccm alcohol-ether poured over. The colored alcohol-ether solution was decanted into a test tube and compared with the standard colors, and with the other sample of the pair, to which one drop of HCl and two drops of ferric chloride had been added. In each case the equivalent color in alcohol-ether was obtained, being much stronger than the water solution control. In all of the samples which were tested in this manner none were found which did not respond to the test as stated.

In regard to this series of experiments several points of interest should be cited. *First*, it was found that, although one drop of ferric chloride was sufficient to bring about a complete reaction with the KCNS in 5 ccm of water solution it was necessary to use two drops for the same amount of a salivary solution. This may be explained by saying that a portion of the ferric compound entered into combination with some of the salivary constituents, and the remaining portion was not sufficient to complete the sulphocyanate reaction. The addition of the second drop usually produced the maximum color. *Second*, it was seen that the resultant color, when KCNS and ferric chloride were added to KCNS negative salivas, was not always the same. In many cases it seemed as if a portion of the KCNS had entered into combination with the constituents of the saliva, and a much lower reading was obtained in both salivary and alcohol-ether solutions than would have been produced in water solutions. *Third*, in making the alcohol-ether solution it was frequently seen that a colored material remained on the watch crystal after the alcohol-ether had been poured off. This was noted by MacDonald and was pointed out by him as a source of error. If this residue is examined it will be seen that after all the alcohol-ether has been drained off, the material is not red but yellow, that it has all the appearances of a colloid, and will not answer any of the tests for sulphocyanate. In view of this, and in view of the fact that we can see no loss of sulphocyanate in our tests, we may infer that this substance is some colloidal iron compound in combination with the mucins of the saliva. The formation of this compound may be almost entirely eliminated, if, instead of stirring the ferric chloride *into* the dried film of saliva, it be lightly smeared *over* the surface, and allowed to stand for a minute or two until the reaction is complete, before pouring on the alcohol-ether. *Fourth*, in the case of the evaporated water solutions, it was necessary to use but a small drop of ferric chloride solution to bring about the complete reaction preparatory to absorption by the alcohol-ether, but in the case of salivas more ferric chloride must be used. Two, three or even more drops are necessary to complete the full reaction, depending upon the viscosity of the saliva. The amount to be used must be determined by the rule that the reaction between ferric chloride and KCNS must be brought about in a *minimum amount of water*. If this rule is followed, the solution will be as complete in the case of the saliva which requires four drops, as with the water solution which requires but one. If an excess of water is used, the balance of equilibrium is destroyed and no absorp-

tion takes place. *Fifth*, it was found that it was impractical to form the ferric sulphocyanate compound in water previous to drying down, for in the process of evaporation some other compound salt of iron is produced which is insoluble in ether. Care should also be taken in mixing the ferric salt with the KCNS solution on the watch glass that the mixture does not dry down, in the event of which the insoluble compound is formed. *Sixth*, KCNS solutions which are to be evaporated and brought up in ether should not be acidulated, as the ether solutions of ferric sulphocyanate are rendered colorless by the addition of acid. The danger that even the weak solutions will be hydrolysed without acidulation is quite remote, as in evaporation the concentration of molecules is increased and the water greatly diminished.

The test as it is carried out by the author at the present time may be stated as follows: Evaporate 5 ccm of the sample to be tested on a watch crystal or small evaporating dish. To the dried film add ferric chloride drop by drop. Spreading it gently with a glass rod. Use just enough to moisten the whole film. Allow the mixture to stand one or two minutes and then pour on 5 ccm of alcohol and ether. Stir gently with a glass rod, until all the color has been taken up by the ethereal solution. Decant solution off into test tube and compare with an ordinary water test of same sample.

According to the foregoing method, a large number of salivas were tested by the author. In these tests it was seen that many salivas gave a resultant red color in the alcohol-ether solution which was much stronger than that in the water solution, the color obtained being approximately equal to the alcohol-ether equivalent of the water reaction. There were, however, many cases in which the alcohol-ether color obtained was no stronger than that of the water solution, and in other cases it was decidedly less. If, as we have seen, KCNS may be detected by the alcohol-ether solution when in the saliva, and if the color thus obtained is stronger than the corresponding water tests, we can but conclude that in those cases in which the proper color is not produced in alcohol-ether, the color seen in the salivary solution is due in part to some substance other than KCNS.

That this test leaves much to be desired is frankly admitted by its author, but it is his opinion that anyone, who carefully carries out the method as suggested upon a number of different salivas, will recognize the discrepancy between the alcohol-ether and the water tests, and will be convinced of the unreliability of the latter. The alcohol-ether test does not specify the nature of the interfering substance, and, indeed the name of its class may be Legion, nor does it eliminate all such compounds, for many of the benzoates, acetates, and other substances are soluble in ether. But, imperfect as it may be, the alcohol-ether test indicates KCNS when it is present. The failure of the ordinary water test to check with that of the alcohol-ether very clearly indicates a multiple reaction which cannot be looked upon as a true index to the KCNS content.

As a more accurate method of determining the sulphocyanate content of the saliva, Dr. Gies suggested the Rupp, Schied, and Thiel iodometric method.* There is no doubt but that the method as given is the most accurate quantative test which we have at our command, but, as Dr. Gies says, it is so complicated that it is not adaptable to clinical uses. The alcohol-ether method as described in this paper has the advantage of easy and practicable working, it is positive to KCNS when present, giving a more vivid

*Ibid.

reaction than the water solution, and it eliminates all those confusing substances which may be present in the saliva, which are not soluble in alcohol or ether.

In the investigation of this reaction, over 200 specimens of saliva were examined, and a careful record taken as to the condition of the teeth and their susceptibility to caries. From these it was estimated that approximately 28 per cent of the immunes were distinctly KCNS positive, and 27 per cent were negative. Of the susceptible cases, 29 per cent were distinctly positive, and 16 per cent were negative. All of such data is open to two serious objections; first, that the samples taken were not a true index to the total salivary secretion for 24 hours, and second; that it is often impossible to say definitely in which class, immune or susceptible, many cases belong. There were, however, among these many clearly defined cases of immunes and susceptibles, and among these we could find no constant relation of the KCNS content of the saliva to the susceptibility of the teeth to caries. From my experience with the subject I can only concur with the findings of Gies and Kahn who consider the sulphocyanates in the saliva but an excretion of the products of protein metabolism, and of no apparent value to the mouth economy.

ALEXINS.

There is no one who has made a close study of this problem of caries who at some time has not wondered whether or not there might be in the saliva some form of anti-body after the form of alexins of the blood, which by their action determined the life history of the caries forming organisms. Upon this question, Miller did considerable work and gave as his opinion* that, "there are neither simple chemical antiseptic compounds present in sufficient concentration to exert a bactericidal action, nor have I been able to find the more subtile protective bodies (analagous to the alexins of the blood) in saliva. In other words the protective bodies of the normal blood serum (alexins, complements, cytase) do not, under normal conditions, pass into the saliva in sufficient quantities to be detected by ordinary means." He goes on to say that further work should be done upon this phase of the question.

We know that the saliva can in no wise be looked upon as antiseptic. Bacteria live and thrive luxuriantly in the salivas of all peoples. It in fact forms the only habitat known for several varieties of bacteria which refuse to grow on any other media. But we also know that wounds of mucous surfaces bathed by saliva, although highly infected, heal readily and seldom suppurate. We know, further, that the dog licks his wounds, and that in so doing hastens their healing. This, of course, has been explained by saying that the blood supply of the mucous membranes is full and that phagocytosis is very active. Also that the saliva as applied to the dog's wounds stimulates phagocytosis in the part. Still there is left the query in our minds as to whether there may not be some governing principle in the saliva which, although it is not bactericidal, may determine the life history of the mouth organisms, and their ability to manifest their characteristic action. Information in this regard is not easily obtained, but it seems that the question is of sufficient importance to warrant further investigation.

THE ACIDITY AND ALKALINITY OF THE SALIVA.

There has been considerable controversy and discussion concerning the effect of the alkalinity and acidity of the saliva upon the process of caries. Certain writers have claimed that an acid saliva is conducive to caries by causing

*Dental Cosmos, Vol. 46, Page 991.

a superficial roughening of the enamel surfaces, thereby favoring the inception of the process. Others have been equally certain that alkaline salivas are the most favorable to caries in that they exhibit a more rapid fermentation of carbohydrates. Miller in looking into this phase of the question gave as his conclusion* "that when foodstuffs which are impregnated with alkaline saliva lodge between the teeth or in cavities of decay a more rapid development of bacteria will take place in them than when the reaction of the saliva is acid, the result being that the alkali is soon neutralized and a degree of acidity brought about equal to or slightly in excess of that produced when the saliva had an initial acid reaction. The excess is, however, inconsiderable * * * * * * * Taking all things into consideration we are forced to the conclusion that the chances for the production of caries are about as favorable in a mouth with alkaline as in one with acid saliva."

In our study of this question we have recorded the reaction of a large number of salivas of which those cited above in table 3, are typical of the whole. In them it was not evident that acidity or alkalinity of the saliva bore any relation to the activity of caries in the mouths from which they were taken, nor were they in any way proportional to the amount of acid formed by fermentation, either in the normal solution or in those to which carbohydrate had been added.

In all of the work which we have done in the investigation of the reactions of the saliva we have been strongly impressed with the unreliability of the reagents which are commonly used for this purpose. In much of the early work which was done upon the saliva, litmus was very widely used as an indicator. In an editorial entitled "The Amphoteric Reaction"* Kirk took exception to the results obtained by the use of litmus in the saliva. He stated that both the alkaline and acid phosphates of sodium and calcium could be present in the saliva at the same time and not be able to neutralize each other, and that one of these salts might by its presence obscure the reaction of litmus with the other. So that he did not consider the litmus as trustworthy for the most common acid and alkaline principles normally found in the saliva. He might have added that litmus is useless for the detection of many of the organic acids, among which is lactic, the acid with which we are so much concerned.

Of the other indicators, phenol-phthalein has been very largely used in biological chemistry and has found wide acceptance among salivary workers. It is very sensitive to weak acids and less so to weak bases. It, unfortunately, is sensitive to CO_2 and is interfered with by the presence of ammonia. In the use of this reagent it has been the custom to eliminate the CO_2 by the process of boiling the solution to be tested, until in the judgment of the individual the fluid is CO_2-free. It is very evident that the process of boiling will have a serious effect upon the character of the saliva and its constituents. The mucins will be coagulated and percipitated, and from them various amino-compounds either acid or alkaline may be split off. The normal saliva is acid to phenol-phthalein when fresh and when boiled many of them become neutral or alkaline as the CO_2 escapes, but the longer it boils the more alkaline it gets, and who shall say at just what point we have entirely discharged the CO_2 and where we begin to form alkaline decomposition products?

Another method of discharging the CO_2 and which has been used in our laboratory, is that of passing CO_2-free air through the sample while warming

*Dental Cosmos, Vol. 46, Page 985.

*Dental Cosmos, Vol. 49, Page 404.

the sample to not over 50° C. This will discharge all the uncombined CO2 from a saturated solution in from five to ten minutes, and, although even this low temperature may break up some loosely combined substances, still its effect is probably less than any other method which would be practicable for our purposes.

As we have stated in previous paper* even by the most careful technic the results obtained with phenol-phthalein as an indicator cannot be looked upon as a true index of the combining powers of the saliva. This fact will be clearly seen when acids are added to salivas which are originally acid, neutral, or alkaline, in which there is invariably a combination of a portion of the added acid with the constituents of the saliva, so that the resultant acidity of the saliva is much less than the combined acid readings of each. This same phenomen will be seen in the combination of acids which are added to egg albumin and other colloidal solutions. When the saliva is dialysed it loses its power of combining with acids. From this we may see that the saliva has an alkalinity which is hidden to phenol-phthalein, and which is able to combine with acids introduced into it from without. Two possibilities suggest themselves; one that it is a weak basic salt to which phenol-phthalein is insensitive, but which is indicated in all salivas by methyl-orange, and which is in loose combination, as shown by its disappearance in dialysis; the other that it is an amino product of the proteins present. The second of these possibilities is in accord with what has been written in chemical literature concerning the absorption of chemicals by proteins.

In the work of Pickerill, he has seen the difficulties attending the use of phenol-phthalein as a salivary indicator and has substituted methyl orange in all of his observations. This reagent is sensitive to the weak alkalis, but has the objection of being but feebly sensitive to the weak acids, and does not possess a sharp end point in salivary analysis. These qualities has made it unsuitable for use as an indicator in our hands, and we have been unable to rely upon it.

The fact of the matter is that there is no one indicator which is pre-eminently adapted for use in the saliva, nor do those which we may employ, operate in the same manner in the saliva as they do in other solutions. The relatively large amount of variable proteins, by virture of the properties which are characteristic of them, interfere with the reactions which we attempt to bring about in the saliva. The solution which we are examining is a combination of three variable secretions, each having its own quota of salts in various combinations, and over all and about all are the viscous colloidal and mucous substances, which makes the accurate determination of any reaction a difficult matter.

In the search for some indicator which might be more reliable for salivary analysis than those mentioned above, we have given considerable attention to the electrolytic methods of determining the free H ion in such solutions. The method which we have used is a modification of that given by Hildebrandt,* in which he makes use of a hydrogen electrode. This method is a simplification of that suggested by Bottger** and consists of the measurement of the difference in potential which occurs between two electrodes, a hydrogen and a calomel, when immersed in the unknown solution as an electrolytic fluid. In the article above referred to, Hildebrandt states the principles of the method and describes a new form of hydrogen electrode and convenient working outfit which we have found

*Dental Cosmos, Vol. 56, Page 288.

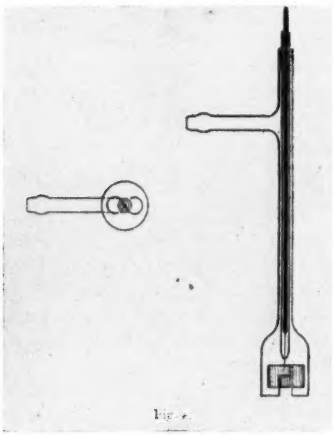
*Journal of the Amer. Chem. Soc., Vol. 35, Page 847.

**Z. physik Chem., Vol. 24, page 253.

adaptable to salivary analysis. The hydrogen electrode as shown in Fig. 11 he describes as follows:

"A platinum foil about 8x10 mm. is welded to a short piece of platinum wire,

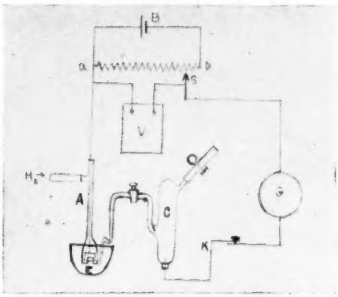
Fig. 11



which is in turn fused to a stiff copper wire. The latter is thrust into a glass tube just wide enough to receive it, which is fused around the platinum wire just above the foil. The copper wire is fastened in the tube at the top with marine glue. This electrode is contained in a slightly wider tube having a side arm near the top for the admission of hydrogen, and a bell shaped enlargement at the bottom to protect the foil and to confine the hydrogen which must cover its upper half. A wide notch is cut in the bottom of the bell to allow the liquid to rise enough to cover the lower half of the foil. After adjusting the inner tube carrying the electrode to the proper height it is fastened to the outer tube by means of marine glue. The platinum has been previously bent into an S-shape so as to pass into the bell. This arrangement of the foil exposes a sufficient line of contact between the phases solution, platinum-hydrogen to prevent the electrode from becoming unsaturated by the currents likely to be taken from it. Before using, the electrode must be covered with platinum black by the usual process."*

The method of setting up the apparatus will be seen in Fig. 12 to consist of two circuits. The first contains a battery B in series with a variable resistance ab. The second consists of the hydrogen electrode A, an ordinary calomel electrode C which are immersed in the fluid to be tested in a crucible E, a galvanometer, G, and a key, K, by which the circuit may be opened and closed. Between these two circuits which are united at a and s, a voltmeter, V, is shunted in. Into the hydrogen electrode a continuous stream of hydrogen is introduced at H2, which hydrogen may be obtained by means of a Kipp generator, and passed through two solutions towers containing permanganate and KOH respectively. The rate of hydrogen introduction should be such that bubbles will escape from the liquid at about one per second.

Fig. 12



A convenient form of battery is that of an ordinary dry cell, its range of 1.5 volts being sufficient for salivary work. The resistance should be sensitive

*See Findlay, Practical Physical Chemistry.

enough to be adjustable to 0.01 volt, and should have a range of 1.5 volt. A very convenient form is that of the fine slide wire resistances which have a range of 420 ohms. The voltmeter should be accurate to and read directly in 0.01 volt, and the scale should be of sufficient length that fractions of each 0.01 volt might be estimated. As a solution holder we have made use of the 4 cm crucibles in which a test may be made in 5 ccm. samples of saliva. This makes a very convenient form of solution cup and is especially adaptable in case the amount of liquid to be obtained is limited. The crucible should be partly immersed in a pan of water by which the temperature may be kept constant. The contact tube of the calomel electrode should be drawn down to a fine point, and a bend made as near the end as possible to lessen the diffusion of liquids from E to C. The liquid contained in the calomel electrode should be a normal solution of KCl, and compounded with calomel according to the methods described in the works on physical chemistry. After each reading, before changing to another solution, a portion of the KCl should be expelled from the calomel electrode to insure freedom from contamination.

The method of taking the readings is as follows: according to the principle of the hydrogen electrode, when it is set up in circuit with a standard calomel electrode the e. m. f. produced will be inversely proportional to the hydrogen ions present in the electrolytic solution to be tested. In electrolytic water where the H and OH ions are equal, the H ion concentration is that of 10.7. In acid solution the H ion is increased and by the law of mass action the OH ion is decreased. In alkaline solutions the OH ions are increased and the H ion decreased. Therefore in solutions which are acid the H ion is high and the e. m. f. is high. The function of the apparatus is that of estimating the e. m. f. generated by various fluids between the hydrogen and calomel electrodes and to estimate by this means the H ion concentration of the solution. With this in view the e. m. f. of the cell, hydrogen electrode—calomel electrode is balanced against a variable fraction of the e. m. f. of the battery B. The latter causes a fall of potential along the rheostat a-b, and by adjusting the position of the sliding contact, s any desired fraction of the e. m. f. of B can be shunted between a and s. When this is just equal to the e. m. f. of the cell composed of hydrogen and calomel electrodes, connected so that the two e. m. fs. will oppose each other*, then no current will pass through the galvanometer G in pressing the key K. The measurement consists, therefore, in sliding s along, until on pressing the key, there is no deflection at G. The fall of potential from a to s is then read on the voltmeter V.

In the article referred to above, Hildebrandt, shows curves by which he represents the results obtained by the titration of various acid and alkaline solutions. In these it will be seen that the neutral point, H ion concentration 10.7 gives a voltage of about 0.69 volt, theoretically 0.686 volt at 20° C. The acids have voltages which are below this point and the alkalis above. As acids are neutralized by alkalis there is a gradual rise in the voltage until the neutral point is approached, and at that place there is a sudden jump of the voltage to the alkaline side as the neutral point is crossed. This makes the method exceedingly sensitive at the neutral point, a small amount of acid or alkali producing a marked change in the voltage reading. It will also be noticed that the shape of the curves for the various acids and alkalis is not alike in all cases. This is obviously due to the fact that in certain concentrations some acids and alkalis are more completely dissociated than

*The calomel electrode will always be positive in this work and should therefore be connected to the positive pole of battery B.

others and would therefore have a greater number of H and OH ions in a free state to affect the hydrogen-calomel e. m. f. This will be seen in the curves of acetic and hydrochloric acids with sodium hydroxide as shown in Fig. 13. The acetic gives a higher e. m. f. than the HCl of equal concentration, and as the alkali is added the increase of voltage in the acetic is more rapid than in the hydrochloric acid.

Fig. 13

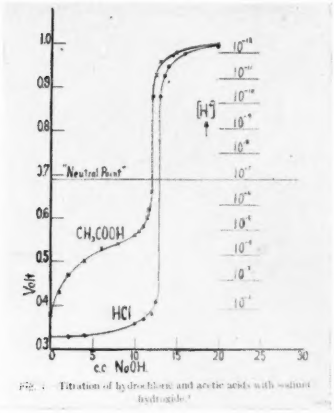


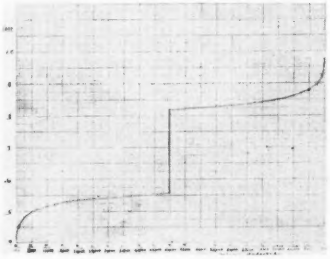
Fig. . Titration of hydrochloric and acetic acids with sodium hydroxide.

To estimate the values of the various concentrations of HC1 and NaOH, we have worked out a table giving the voltage obtained at the normalities ranging from n-100 to n-50,000. These values are as follows:

HC1	n-100	0.399	Volt
"	n-200	0.417	"
"	n-500	0.440	"
"	n-750	0.450	"
"	n-1000	0.457	"
"	n-2500	0.480	"
"	n-5000	0.498	"
"	n-7500	0.508	"
"	n-10,000	0.515	"
"	n-50,000	0.556	"
NaOH	n-100	0.973	Volt
"	n-200	0.955	"
"	n-500	0.932	"
"	n-750	0.922	"
"	n-1000	0.915	"
"	n-1250	0.892	"
"	n-5000	0.874	"
"	n-7500	0.864	"
"	n-10,000	0.857	"
"	n-50,000	0.816	"

The table of normalities may be plotted in a curve as seen in Fig. 14 in which it will be noted that dilution of the acids and alkalis give values which travel in a smooth curve toward the neutral point which is 0.686 volt. The rise and fall of the curves in normalities over 1-5000 is much more rapid than between 1-5000 and 1-50000. The extreme dilutions of n-50,000 acid and alkali are quite widely separated in voltage, 0.556 and 0.819 volt, and the crossing over to and through the neutral point takes place in concentrations between these two points. It

Fig. 14



must be remembered that these figures are true only for the normalities of HCl and NaOH, and that other acids and alkalis having different ionizations would give different readings for equivalent normalities.

In the application of the hydrogen electrode to the estimation of the acidity and alkalinity of the saliva we have tested the secretion of a large number of different individuals. In all cases which we examined the reading obtained was invariably on the alkaline side of the neutral point. None were seen which read acid, nor did they go above 0.85 volt. This is in accord with the statement which Hammersten* makes of the work of Foa, who says that "the actual alkalinity (OH ion concentration) is al-

*Ibid page 343.

ways considerably less than that found by titration, and the reaction determined electrometrically is very nearly neutral." Hammersten quotes Stricker as reporting cases in which the reaction is acid in salivas taken after meals. The great similarity of the readings and their slight variation, makes the method of little avail for direct readings in the saliva.

Fig. 15

A general view of hydrogen electrode set up.

Information may be had, as to the acidity or alkalinity of the saliva by titration with various acids and alkalis. When acids and alkalis of known strength are added to saliva there is seen a variable response in the change of voltage readings, i. e., some salivas respond in this manner more readily to additions of acids and alkalis than do others. For the purpose of obtaining information in this regard the following method of study was adopted. To one sample of saliva

en equal quantity of HCl n-100 was added. Had the dilution of the acid been that of water instead of saliva, the result would be a solution of HCl n-200, which would give a reading of 0.417 volt. The mixture of acid and salivas, however, read much higher than that figure, being from 0.5 to 0.8 volt. The difference between these readings and 0.417 volt, the value of n-200 HCl is a measure of the amount of acid neutralized by the saliva, and an index of the true alkalinity of the saliva. In a similar manner a second sample of saliva was taken and to it was added an equal quantity of NaOH n-100. As with the acid, this solution would be equivalent to n-200 had water been used instead of saliva, in which case the reading would be 0.955 volt. The values obtained with the saliva-NaOH mixtures were all less than

that of n-100, ranging from 0.9 to 0.7 volt. The difference between these values and 0.955 volt, that of n-200 is the measure of the amount of acid neutralized by the saliva, and an index to its true acidity. A large number of readings were made according to this method of which the following data are characteristic:

	Alkalinity	Acidity
Case 1	0.295	0.105
" 2	0.296	0.116
" 3	0.305	0.110
" 4	0.107	0.125
" 5	0.300	0.115
" 6	0.133	0.093
" 7	0.271	0.101
" 8	0.307	0.143
" 9	0.313	0.116
" 10	0.349	0.101
" 11	0.301	0.103
" 12	0.281	0.201

Thus it appears that all salivas have the power of combining with a variable amount of acid and alkaline substances. That this amphoteric action of the saliva is due to the action of salts or certain amino-compounds which are easily slit off is shown by the fact that when any of these salivas are dialysed they apparently lose all their powers of combining either with acids or alkalis and act upon them similar to water. A large quantity of saliva was dialysed for three days and a qualatative analysis made of the salts which had been extracted by the process. The following compounds were obtained: Sodium, potassium, calcium, magnesium, phosphates, chlorides, carbonates, and sulphocyanates.

Still another method of salivary determination may be used, namely, electrolytic conductivity. In this regard Mr. Fahrenwald of the Research Commission, made a series of tests at the suggestion, and under the direction of Dr. Price, in which he used the conductivity method for the purpose of checking our results. The report which follows shows a strong agreement with the results which we obtained with the hydrogen electrode, especially in regard to the amphoteric action of the saliva.

SOME CONDUCTIVITY DETERMINATIONS FOR ACIDITY AND ALKALINITY OF SALIVA.

By Weston A. Price, D. D. S., M. S. and F. A. Fahrenwald, B. S., M. S.

"The apparatus used in making these tests was that installed in the department of electro-chemistry of the Case School of Applied Science and was imported from the firm of Fritz Kohler, in Germany. This is said to be one of the most delicate and sensitive installations in the United States. Figure 15 shows the general arrangement of this set up. The current here is derived from three dry cells and is changed to alternating current by means of the vibrator shown. The number of vibrations, as judged by the tone produced, was approximated about 800 per second, thus eliminating any danger of electrolysis in the solutions. The conductivity cell consists of the Jena glass container indicated, (see Fig. 15) into which the solution is placed. The electrodes are thin discs of blackened platinum, and are adjustable as to the distance between them.

"The method of operating is, briefly, as follows: Assume that the solution to be tested is in the container. The resistance of the solution now, is unequal to the external resistance. In this case a small amount of current will flow across the bridge wire and to the telephone receiver. By sliding the adjustable contact back and forth, a point is reached where there is a minimum current passing through the shunt, as is indicated by a minimum sound produced in the receiver. This bridge reading is now taken, and the conductivity of the solution is slightly decreased by adding pure water. A new zero point is now found and when a sufficient number of points are so located, they form a curve, which graphically shows results of the determination.

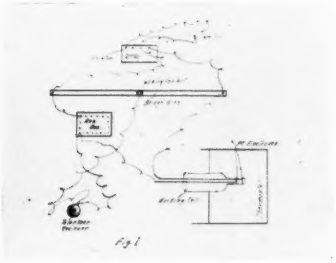
"Figure 3 is the curve so obtained when saliva is diluted in successive stages by

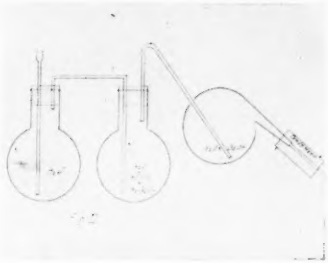
the addition of pure water. The water used in these tests was triple distilled. Ordinary distilled water was redistilled from a solution of sulphuric acid and potassium dichromate, which should oxidize all organic matter present. This was passed through a sealed tube to a vessel containing barium hydrate which should eliminate all carbon dioxide formed. The water was then redistilled from this solution and used directly, both for making standard solutions and for the dilution tests. Figure 2 shows the arrangement of this distillation apparatus.

"As compared with pure water, or the very dilute reagents used, the conductivity of saliva is very great. Figure 3 is a curve which shows, very clearly, the decrease in conductivity upon addition of pure water. It was thought desirable to test the method first for its accuracy in determining the acid and alkali content of pure solutions. For this purpose, a solution of hydrochloric acid and sodium hydroxide were made up, using the conductivity water made for this purpose and diluting until the solutions were approximately n-1000, i. e. contained 1-1000 of the moledular weight of the material per liter of solution. For HCl, this is about a 0.36 per cent solution and for NaOH a .4 per cent. solution. Curves 1 and 2, Figure 4, show how well this worked out, and gave an end point which was much clearer than that indicated by phenol-pothalein or methyl-orange.

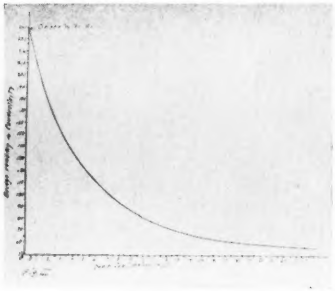
"In the necessarily short time allotted to this work, it was impossible to determine the effect of various acids and alkalis in neutralizing the saliva solution, and as hydrochloric and sodium hydrate solutions were chosen, the results given here would not necessarily apply to the weaker acids and alkali solutions. Where a known amount of saliva was desired, it was either weighed in the conductivity cell, or measured by means of a special burette.

"Many alkali and acid titrations were made on the concentrated saliva solution, but, resulting curves apparently differed in no way from the dilution curve shown in Figure 3. The probable explanation for this is that the end point, or neutralization point came so near the beginning of the curve, and, where the fall was so rapid that it was not detected. After trying for some time to remedy this difficulty, the following method was evolved, and which, so far as technique is concerned, worked very well. To a known amount of saliva solution there was added a known amount of the standard alkali solution. This, then, was titrated back with the standard acid solution with results shown in Figure 5. Curves 1, 2 and 3 show the neutralization point at 4.35 cubic centimeters of the added standard acid solution. These were triplicate

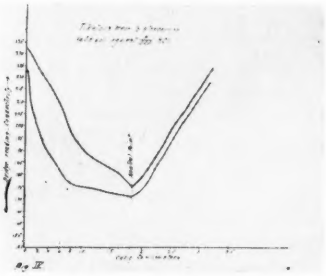


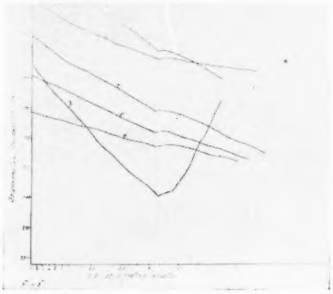


runs on alkaline solution containing no saliva. Their different relative positions are caused by the different dilutions used purposely in each case. The end points, however, check. Curves 4, 5 and 6 show the results of titrating the same amount of alkaline solution containing each 3 c. c. of saliva solution. In running these exactly as before, the end point came, in each case, at 4.2 c. c. of the added HCl solution, showing an apparent decrease in alkalinity, due to the saliva present, of 0.15 c. c. of the added acid solution. This as a measure of acidity, was all that could be wished for, but when this operation was reversed, and



the saliva solution containing acid titrated with alkaline solution, the same saliva gave a decided indication of alkalinity, having apparently consumed some of the added acid. This same discrepancy was detected in seven different duplicate determinations and would seem to indicate that a certain decomposition or formation of other salts was taking place, so that as far as the stronger bases and acids are concerned, the method would seem to be worthless in connection with their neutralization of saliva, and the detection of that point by a change in conductivity of the solution. It does not, necessarily, follow that similar reactions would take place if some less active reagents were used. It was necessary, in all determinations, to dilute the saliva solution until the conductivity was very little or no greater than that of the titrating solution, in order to emphasize the end point. Otherwise, the curve would be a duplicate of the dilution curve, Figure 3, with a fall so rapid that the faint critical point would be overlooked. Perhaps, also, if these same experiments were performed with the impurities present in the acid and alkali solutions, corresponding to the salts found in the saliva, and explanations could be worked out."





From the work which has been done upon this phase of the subject there seems to be evidence to the effect that all salivas are able to combine with acids which are introduced into them from without, and it is reasonable to as-

sume that they have the same effect upon those acids which are formed in their own environment. We have also seen that this combining effect is a variable property, existing in some salivas to a greater extent than in others. It is but a step farther, then, to infer that certain salivas by their neutralizing effect may render inert much of the acid formed in the mouth by fermentation. So that in case the process of lactic acid fermentation were not completely enveloped by a non-permeable plaque or film, a saliva which is high in free alkaline compounds may be looked upon as an important inhibitive factor in the process of dental caries.

As a further substantiation of this view we have the work of Head* who found that the addition of salivas to acid markedly decreased their power of the acid to decalcify tooth substance. Also that certain salivas may under certain conditions restore a partially decalcified enamel surface to apparent normality. All of which serves to impress upon us the importance of the combining powers of the saliva upon the process under consideration. We feel that we have but begun our work in this direction and unless it appears that our method is untrustworthy we intend to continue our electrolytic tests in the hope of obtaining further information. We wish to do further work with the weaker acids and bases, and also with acids of fermentation. We have done considerable work along these lines which will not be reported at this time, as we hope to add to our results and determine, if possible, their true values.

OTHER SUBSTANCES.

In addition to those substances which directly help or hinder the process of caries there are several others which may be of greater or less importance. Of these the suggestion of Howe* that the presence of a large amount of phosphates increased fermentation, while the presence of chlorides inhibited, may be of direct import. In such a case the rate of fermentation would not depend so much upon the nature or amount of infection present as upon the character of the media upon which it grew, phosphatic or chloride.

So also the amount and fluidity of the salivary secretion may be taken into account. It has always been said that a copious flow of saliva is inhibitive to caries, and the lower incisors have been cited as cases of immunity produced by the continuous presence of saliva. In this regard, several cases have come under our notice in which the salivary secretions were unusually large and watery, and at the same time the teeth were exceedingly prone to caries.

Thus it would be possible to state numberless theories and possible factors which might enter into a consideration of this subject. We have given, however, those factors which seemed to us to be most important and most worthy of consideration. We have attempted to state each in a fair and unbiased manner, giving the more recent opinions upon the various subjects. Our conclusions have been drawn from personal observations and are but a statement of the present view which we now hold in regard to these matters, and which subsequently be changed by further work of those who are engaged in the study of this problem. The work which we have accomplished has served to impress us with the fact that the end is not yet, that the problem is a difficult one, and that further work should be put upon it, especially in the investigation of the nature and function of the plaque, the neutralizing power of the saliva, and the self-cleansing factors of the oral cavity.

*Jour. of Amer. Med. Assn., 1912, Page 2118.

*Dental Cosmos, Vol. 54, Page 567.

REPORT OF THE MOUTH-INFECTION RESEARCH CORPS OF THE NATIONAL DENTAL ASSOCIATION

For the Year Ending July 1, 1914

Thomas B. Hartzell, M. D., D. D. S., Research Professor of Mouth Infections, School of Medicine, Univ. of Minn., Professor of Oral Surgery and Clinical Pathology, Coll. of Dentistry, Univ. of Minn., Director.

Arthur T. Henrici, M. D., Bacteriological Research Assistant.

Harold J. Leonard, D. D. S., Hospital Research Assistant.

(Read Before the National Association at Rochester, N. Y., July 7, 1914)

THE work of the corps was commenced in September, 1913, since which time we have observed and studied the mouth flora of eighty-two cases, a part of which work in the beginning of the year was done by Mr. D. W. Gaskill. Some of these cases were taken under observation for the purpose of acquainting ourselves with the general flora of the mouth. Others were taken under observation for the special purpose of determining whether or not the mouth infections present were responsible for existing secondary constitutional infections. The general plan of the work of the corps has been to study our cases clinically and to afford to them effective local treatment in addition to the ordinary forms of treatment approved by the medical staffs of the hospitals where our cases have been quartered. The bacteriological research has sought to determine the character of infection present in pyorrhoeal pockets and apical abcesses, and, if possible, to determine by animal inoculation the character of the damage wrought in the various organs of the body by the introduction of intravenous injections of living organisms of the kind found in the lesions in the mouths of the patients studied.

The data gained by animal inoculation and a study of the lesions caused in the animals, has been supplemented in some cases by the use of autogenous vaccines, administered to the patients themselves, to the end that we might by observing the reactions resultant from such administration, gain light as to the character and relationships of the organisms studied.

The research has been conducted largely on cases in the Eliott Hospital which is the teaching hospital of the School of Medicine of the University of Minnesota.

The research corps has enjoyed the full co-operation of the Dean and heads of departments of the School of Medicine as well as house officers and nurses of the hospital, and the writer desires to make particular mention of the help afforded us by Professor W. P. Larson of the department of Bacteriology, whose experience and counsel have been of great value.

In addition to the cases studied in the University hospital, the research corps

has made a study of interesting cases wherever they have found them.

One such was, case 60, referred to us by Dr. John Macnie, whose records of it are complete, and case 59, referred by Dr. Chas. A. Griffith, superintendent of the infirmary of the College of Dentistry.

All of the cases studied in the Eliott Hospital were undertaken only after a careful examination and diagnosis had been made by one or the other of the associate professors in medicine, Drs. Head and White.

These examinations included examinations of the blood and urine and a Wasserman test wherever there seemed to be the slightest need for them, and we have made a bacterial search in every instance.

The first step with all our patients has been a thorough cleansing of the oral surfaces, scrubbing the mucous membrane and tongue as carefully as possible. Our second step has been a vigorous cleansing of tooth surfaces, saturating them with iodine after which sterile gauze was packed around the teeth to be investigated, thus excluding saliva. Further efforts to prevent contamination of the material taken were made as follows:

The teeth were rubbed dry. Then the actual cautery was passed under the margin of the gum to destroy the superficial flora beneath this margin, and in the pockets, usually flooding the area a second time with iodine. Particularly was this done in the first series of cases. At this point abscessed teeth were extracted and the root end snipped off with sterile Rongeur forceps. The root tips were dropped in appropriate culture media and a second planting was taken by curetting the socket from which the tooth was extracted when a number of teeth were diseased in the same mouth, the plan of extracting only one tooth at a time was followed in some cases, making two plantings of material, one for ærobic and one for anærobic cultivation. The object for taking only one tooth at a time was to conserve material, feeling such conservation was necessary because of possible failure to obtain cultures in the first instance. Whenever good virile cultures were obtained from the first planting, a thorough cleansing of the mouth was commenced, extracting all diseased and abscessed teeth and affording an effective pyorrhœa treatment when necessary. This part of the work has been done by Dr. H. J. Leonard, hospital research assistant. The bacteriological research has been conducted since February first by research assistant Dr. Arthur T. Henrici, of the School of Medicine, whose work has been exceptionally efficient and valuable and to whom the director accords unstinted praise.

It would not be profitable for the director of this research to burden the commission with a detailed description of the work done on each case, and he will therefore choose from the various cases treated, those patients illustrative of the work accomplished. It was the belief of the director of this research that more could be gained from a combined clinical and laboratory research than by following either line alone and we desire to draw your attention to the results gained from each branch of the work. The value of surgical treatment is illustrated by the case records which are to follow.

Perhaps the most interesting and valuable thing brought out by the research so far as it has been conducted has been the remarkable constancy of streptococcus viridans findings in all the cases studied. In the eighty-two cases from which bacterial specimens were taken, seventy-five of them have presented streptococcal growth, and in the last thirty-five cases, identification of the streptococcus so constantly found has been perfect and complete, the organisms

being the streptococcus viridans. The cultural characteristics of thirty strains from twenty-six cases have been tabulated by Henrici and appear in our report.

The next most striking and suggestive thing about the research has been the causation of a diverse character of lesions in the animals inoculated; these lesions occurring in arteries, joints, kidneys and heart, which latter organ has presented myocardial inflammation, and in one rabbit we found a hemorrhage at the base of one of the heart valves, apparently a beginning endocarditis.

LOW VIRULENCE.

Another fact that constantly impressed us was the comparatively low virulence of these streptococci, though in the end the damage wrought by them in the animal economy was serious and in some cases irreparable.

The analysis of this work points to the fact that the elimination of the principal foci; to-wit, dental abscesses and pyorrhœal infection is always most important and the first step to be taken in all cases, and vaccines are indicated only when elimination of the primary focus fails to give relief.

Our research has been dominated by the belief that we could gain most from a study of the organisms at work in the dental path. Therefore, we have only studied the bacteria found deep in the tissues near the teeth. Though the mouth may contain many varieties of bacteria, we believe our problem has to do with those which enter the tissues by the door and through the path the teeth afford. To make this more graphic, I would like to draw your attention to the fact that the ordinary denture has a total circumference of thirty inches at the gingival line. It follows that an inflammation involving one-eighth of an inch of the gingivae would mean an area of three and three-fourths square inches of germ infected tissue. The area involved in an abscess, though smaller, is more dangerous because almost all the organisms produced enter the circulation.

The constant finding of streptococci in the tissues about all the teeth we examined caused a feeling in our minds akin to consternation. We therefore commenced a series of examinations of living healthy teeth and their environs. This sort of research was difficult because people do not wish to part with healthy teeth, so the number examined was small, seven in all, none of which produced a culture. We necessarily observed the same careful technique to prevent contamination of the extracted teeth by other mouth bacteria, but we found the root-tips of these seven teeth produced no growth in sterile media nor did the bone curetted from their sockets produce growth.

We found, however, that the root-tip of a sound healthy tooth taken from between abscessed teeth or teeth affected with pyorrhœa would, no matter how careful our technique, yield streptococci. It was therefore a great satisfaction to find even a short series that were free from infection.

Because of the fact that the director of this work has constantly observed a relationship between arthritis and mouth infection, we have chosen principally rheumatic patients for investigation and in this matter we have been fortunate, for the University hospital contains at all times a number of such patients, so we have had more material than we could profitably use, for where one endeavors to thoroughly test every link in a chain of evidence, the work proceeds slowly. In the hospitals over one hundred cases were examined. Of this number seventeen were selected for research. The report of these seventeen cases treated in the hospital, while not given in full, has been filed and is at the disposal of the association. We present herewith four characteristic case records, which are streptococcal infections of various sorts.

MR. ERNEST SWANSON, NO. 82.

A young American college student of twenty-four years. Has always been in perfect health until four years ago when he had an attack of acute articular rheumatism, in which his heart was affected. He remained in bed three months with this attack. Nine months later he had a similar attack, accompanied by heart trouble from which he was in bed for two months. Two years ago he had a similar attack confining him to his bed for three weeks. His present illness started four days before entering the hospital, with pain and stiffness in the joints and disturbance of the heart action. The pain in the joints upon movement gradually diminished, while the heart condition grew worse. At the time of entering the hospital and for some time afterwards his heart condition was serious enough to be very alarming. He lost rapidly in weight and it looked as though he had little chance for recovery. A careful diagnosis was as follows:

1. Acute rheumatism.
2. Pericarditis with effusion.
3. Mitral insufficiency.
4. Aortic insufficiency.
5. Chronic passive congestion of lung.
6. Chronic passive congestion of liver.
8. Ascites.
8. Edema of extremities.
9. Nephritis.

A blood count showed fourteen thousand leucocytes on the day after he entered, and fifteen thousand a week later. A urine analysis showed abundant albumen and numerous granular and hyaline casts.

This patient was in the hospital five weeks before he was treated dentally. At this time it was discovered that a crown had come off a lower molar and pus was flowing through the pulp chamber. This tooth was extracted and almost immediately the patient began to improve. In less than three weeks he was up and around and well on the way to recovery and in five weeks was discharged. It was the opinion of the medical staff that this patient's systemic condition was due to this abscessed tooth and that the removal of this tooth allowed the patient to recover.

MR. FRANZ SCHULTZ, NO. 1.

Admitted October 15, 1913. Patient is a big German fifty-seven years of age, by occupation a watchman.

For the last ten years he has been troubled with a dull aching over the left eye and occasionally extending over the whole forehead. In the winter of 1912 he began having a neuralgia which was near the shoulder. This was so bad that he could not sleep in bed for twenty-five days. Thereafter he had a trifacial neuralgia on the left side, accompanied by a dizzy sensation. He has been unable to sleep because of the pains in his head.

At the time of entering he was morose and discouraged because of his long illness with no apparent relief.

An examination showed nothing was particularly the matter with the cranial nerves. There was a slight deafness, the tonsils were slightly congested, there was a tenderness on pressure over the left orbit and antrum and teeth were in bad condition with abscesses and pyorrhœa.

A diagnosis of pyorrhœa alveolaris neurasthenia and neuritis (5th nerve) was made. During the two weeks of hospital care before the teeth were touched there was no improvement. From Nov. 1-13 to Dec. 1-13 the diseased teeth were extracted and treated and the mouth put in the way of a healthy condition.

As the work progressed his condition steadily improved. A note of Dr. Hamilton's of December first sums up the situation:

"He has been steadily improving since his treatment for pyorrhœa has begun and for over two weeks has had no head-

ache at all. He is much brighter and more cheerful, makes no spontaneous complaints of any discomfort when specially questioned. Says his neuralgia and dizziness have disappeared. There is still some pain (slight) in the right upper jaw where an abscess has formed."

MR. JOHN ANDERSON, CASE 64.

This patient is a Scandinavian of fifty-three years, formerly a plasterer but lately a flagman on the railroad. This case is diagnosed by the medical staff as pernicious aenemia with the following additions:

Slight cardiac enlargement.

Pyorrhœa Alveolaris.

Chronic bronchitis.

His illness started seven years ago with slight attacks for a few minutes each day of chills and fever followed by vomiting. These attacks had no relation to his meals.

Since this time he has gradually though intermittently grown weaker. He has had trouble for some time with swelling of the limbs and with dizziness. His color became pale and yellow and it grew dull and listless.

Every day at about three in the afternoon he would have a sharp pain in the epigastric region and would vomit about one-half glass of yellowish fluid, which relieved him.

He has been under treatment at various hospitals for short periods, several times during the last three years.

At the time of entering the Eliott Hospital he was weak, yellow in color, with constant pain in his stomach and seemed only dully conscious.

An examination showed heart enlargement, an enlarged thyroid and slight pyorrhœa with some rarefaction about two root ends.

He was immediately put on iron and arsenites which have been continued ever since. From March thirty-first his mouth has been under dental care and has become healthy to all appearances. Up to the time that the dental work was done there seemed to be but little improvement, except a slight improvement in the blood count. Since that time he has been steadily improving. His consciousness has returned to normal and his other symptoms have been much improved. The most striking picture, however, is presented by his blood count, which has steadily risen from nine hundred thousand red blood corpuscles and fifteen percent hæmoglobin to two million, six hundred thirty thousand red blood corpuscles and sixty-five percent hæmoglobin.

The only serious drop in red blood count occurred about June 16th, coincidentally with a dental abscess. The writer insisted on the removal of the abscessed tooth and the last blood count jumps from 1800000 to 2500000 and the hæmoglobin is the highest it has been since commencing his record.

BLOOD EXAMINATIONS.

	3-12-14	3-13-14	3-21-14	3-27-14	3-31-14	4-4-14	4-8-14
Erythrocytes	900000	900000	800000	1100000	1000000	1600000	1500000
Leucocytes	3200	6000					
Hæmoglobin	15%	16%	20%	30%	30%	40%	38%
	4-11-14	4-16-14	4-20-14	4-26-14	5-1-14	5-1-14	5-15-14
Erythrocytes	1800000	1800000	2100000	1800000	1900000	1800000	2500000
Leucocytes							
Hæmoglobin	43%	52%	46%	53%	48%	53%	57%
	5-23-14	5-29-14	6-10-14	6-16-14	6-25-14		
Erythrocytes	2700000	2400000	2630000	1800000	2500000		
Leucocytes					5000		
Hæmoglobin	57%	63%	61%	55%	65%		

MRS. BURNHARD LIND, NO. 2,

Entered hospital Feb. 23, 1914. A Norwegian woman of thirty-one years, occupied as a housewife and mother of three children. She had rheumatism three years ago in which all the joints were involved, one after another becoming swollen and painful. She has been troubled with rheumatism to some extent ever since. At that time her heart was affected so that at the time of entering the hospital she had dizzy spells, palpitation of the heart, shortness of breath, and cold tingling extremities upon exertion.

Fifteen months before entering the hospital, her left eye began to swell, sharp shooting pains traveled from eye to jaw and temporal regions. She had photophobia and constant overflow of tears. When her eye became bad she also had chills and fever. This eye distressed her for three months during which time she could not see. She was in the hospital most of this time and was helped some by local treatment.

Since this time the trouble has recurred and during the four months before the patient entered the hospital the pains became such as to be almost unbearable. During this time the left ear became involved so that total deafness ensued on that side. A watery discharge from the nose troubled her by making her nose very sore.

At the time of entering the hospital she was blind in her left eye, had iritis, was deaf in her left ear—the nares and pharynx were inflamed—she had rheumatism, a double mitral lesion and aggravated trifacial neuralgia.

An examination showed several broken down and abscessed teeth, especially on the left side.

During the month of March the diseased teeth were extracted and the mouth rendered healthy in appearance. On March 30th the following note was made by Dr. Geo. Head:

"Patient is improving steadily each day. No more facial neuralgia, inflammation of the left eye subsiding. Patient's color is much improved. Patient has markedly improved since teeth were extracted."

A note of April 6, 1914:

"Patient has had all carious teeth and the tonsils removed. Since teeth have been removed neuralgia of face has disappeared, left eye is greatly improved and hearing in left ear is as good as in right. Marked general improvement."—P. S. Dorge, House Officer.

She was dismissed April 8, 1914, cured of all her ailments.

These four cases, 82, 1, 64 and 2, illustrate what elimination of the primary foci will do for the average individual. Case 82 had a great variety of ailments involving heart, joints and kidneys and the blood count indicates a distinct infection.

Case one is a type common to the practice of almost every dentist and the recovery phenomenal.

Case 64 is one of pernicious anæmia, one of four which have come under the notice of the writer during the last winter. Pernicious anæmia is a disease characterized by exacerbations and remissions and usually death is the end result. This particular case has made a fairly steady rise in the number of red blood cells and in percentage of hæmoglobin, having had only one backset which occurred very recently and this backset was coincident with the occurrence of a dental abscess at which time the hæmoglobin dropped back from 61 per cent to 55 per cent, the red blood cells dropping back from 2630000 to 1800000. The blood examination chart will be found with the case record. The study of the case reveals the fact that we found a heavy infection in the tooth neighborhood in which the streptococci predominated. It also shows steady gain when the intake of streptococci

was checked, and the increase in red cells and dropping markedly when a new dental abscess developed is strongly suggestive of the possible fact that pernicious anæmia is also due to hæmolytic streptococcal infection and it may be possible that this type of case may be greatly benefited by a comprehensive research devoted to this disease alone.

Case 2, that of a woman, is illustrative of a very common type of patient in the practice of every occulist in which we have secondary eye infection which seemed directly traceable to infection in the dental field. We did not make a bacteriological research on this particular case as it recovered so rapidly under treatment that the patient was dismissed from the hospital fully cured, but in passing I would like to draw your attention to the fact that case 60, of which I shall speak later was one quite similar to this case in that the patient had come into the service on account of severe and destructive iritis. The bacterial research revealed streptococcus viridans and with the streptococcus viridans from this patient we were able to produce the lesions shown in the autochrome plates three and six which are acute myocarditis and polymorphonuclear abscess in the medulla of a rabbit's kidney.

In studying the seventeen cases as a whole from which these four cases were selected there are certain points which stand out significantly. They are: First blood taken from patients suffering from arthritis has in no case so far disclosed bacterial growth though it should be noted here, that most of these cases were more or less chronic in type. One would not therefore expect to find increased temperature or bacteria in numbers in the blood stream.

Second, fluids aspirated from rheumatic joints have in no case so far shown bacterial growth.

Third, in but two hospital cases it was demonstrated that the vaccines did a great amount of good. These two cases were reported in the Bulletin earlier in the year and were aged twenty-one and thirty-two years. However, we have records of three cases which were treated outside the hospital with excellent results. It is only fair to state in this connection that the hospital cases were in the main people beyond the meridian of life.

Fourth, our observation thus far seems to indicate that vaccines are of comparatively less service to the aged than they are to people of fewer years. However our research was not concerned particularly with the study of vaccines but rather a study of infections, and vaccines. as stated before, were resorted to in the earlier part of our research to throw some light if possible upon the nature of the infecting organisms and to perchance learn by the use of them, whether or not there existed a relationship between the organisms found in the mouth and those presumably at work in the tissues of the patient elsewhere.

Fifth, in one of our cases in which the vaccine experiment was tried, the vaccine proved to be positively harmful rather than beneficial.

Sixth, in our rheumatic cases, ten out of twelve showed a consistent improvement on the removal of abscessed and infected teeth.

Seventh, in three cases of iritis with neuralgia there is no question but that phenomenal recovery was entirely due to the removal of an infected area in the mouth.

Eighth, there is a question as to whether the streptococci found in the mouth are identical with or nearly related to the low grade streptococci causing distant infections in other parts of the body, but accumulating evidence seems to point to the fact that the mouth offers a field for the obtaining of streptococci of sufficiently close relation-

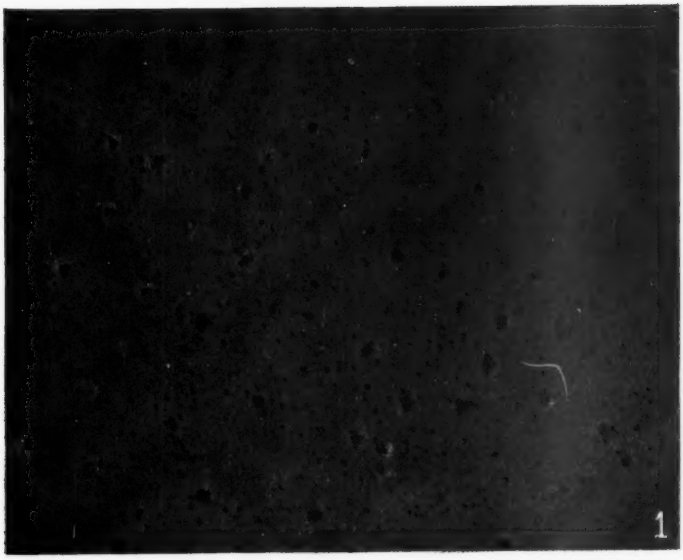


Figure 1

Blood agar plate showing colonies of streptococci viridens. The green colonies have been tinted to accentuate the colour. A number of small, grey colonies are also present.

Figure 2

Chronic myocarditis. The section shows the heart muscle of a rabbit which died 16 days after an injection of streptococci from case No. 55. The section shows an area of fibrosis with several giant cells.

ship to those disturbing the joints, heart, and kidneys to be of service to both physician and dentist to build up immunity when it is impossible to obtain a supply of organisms in the deeper regions of the body where they may have located.

I will now present the hospital and laboratory data gathered from the intensive study of six cases of persons who were suffering severe mouth infections and presented also arthritis and both myocardial and endocardial lesions.

Case 55—Patient is a married woman of forty years of age. She is of German descent, by occupation a housewife, weight 150 lbs., of good habits, with no trace of familial or venereal disease.

Menses began at thirteen years of age, were regular and of three days duration without pain. She has had twelve children, of whom eleven are living. The first and seventh were delivered with instruments. The last baby died in convulsions a week after birth three years ago. She has had no miscarriages and no abortions but has prolapse of the uterus for the past seven years.

She was never strong or well as a child but never had other than children's diseases until ten years of age, when she had an attack of acute arthritis, in which the joints were swollen and the heart involved. At eighteen she had a similar attack. Her heart has given her trouble ever since the first attack. It has only affected her by making her short of breath on exertion until June, 1913. At this time she became weak had palpitation of the heart on slight exertion and had spells of feeling faint. During this time she was in bed two months with the heart condition.

When she came under our care, Jan. 18, 1914, her diagnosis was as follows:

1. Pyorrhœa Alveolaris.
2. Congestion of the lung bases.
3. Cardiac hypertrophy and dilatation.
4. Mitral incompetency and stenosis.
5. Congestion of liver and abdominal viscera.
6. Varicose veins.

She was bed ridden and in bad condition. On Jan. 26th to 30th rheumatic symptoms began to develop in her arms and shoulders. There was no swelling in the joints but they were tender and sore to palpitation.

From Feb. 7th to March 10th, the teeth were extracted by slow stages. Many were loose and many were mere roots, all of the unhealthy ones were extracted. The sound ones were treated for pyorrhœa and the mouth put in healthy condition. Some of these extracted roots were used to get cultures for animal experiment and for a vaccine of which the first injection of five million units was given on March 27th. From this the patient felt a little tired and sleepy for two days while the right hand showed a more acute rheumatic condition. This whole hand and arm had by this time become blue and slightly numb and ached a great deal.

At the present time, her vaccine has been increased to one hundred and fifty million. She is up and around the hospital in good condition, being only troubled by a lingering congestion in the right hand and arm. Her heart has very greatly improved as have all the other ills with which she has been affected. She leaves in a day or two to go back to her home.

In view of the fact that salicylates, rest and quiet have been afforded the patient, we have no clinical proof that the vaccines were of benefit.

This case is chiefly interesting because of the fact that from a streptococcus viridans infected, isolated from abscessed teeth, we have been able to produce myocarditis of a chronic type and also an inflammation of the knee joint in a rabbit which was inoculated with this culture. The myocarditis is illustrated by plate number two.

Cultures were obtained from four root tips and incubated ærobically and anærobically. In all the cultures there was obtained a growth of streptococci which produced green colonies on blood agar plates. In one culture the bacillus pyocaneus appeared. The others were pure. This streptococcus had the following cultural characteristics:

Agar slant—thin, veil-like grey streak.

Broth—turbid, with a granular sediment.

Milk—Acid, coagulated.

Carbohydrates—Acid was produced in dextrose, lactose, maltose, and saccharose. Mannite, salicin and inulin were not fermented.

The streptococci from 40 cc. of a twenty-four hour broth culture, centrifuged and washed, were injected into an 800 gram rabbit on 2-24-14. The injection was made intravenously. This rabbit died on 3-12-14. At atopsy there were found a number of small fibrous streaks in the heart muscle. Both knee joints contained an excess of thick, glairy fluid. Blood cultures remained sterile.

Sections of the heart muscle showed large areas in which the muscle had been replaced with dense scar tissue. These areas contained occasional endothelial giant-cells. Sections stained by the Gram-weigert method failed to show any cocci.

The acute myocarditis shown in figure three occurred in the heart of a rabbit, following the injection of streptococcus viridans obtained from an acute dental abscess associated with an old and prolific pyorrhoeal inflammation occurring in case sixty, which case also produced the polymorphonuclear abscess shown in plate six. At the time the tooth was removed, the patient, a man, suffered from a severe and painful iritis which commenced to recede within a few hours after the removal of the abscessed tooth.

It is interesting to note that this patient had an endocarditis, which induced a mitral stenosis.

LABORATORY RECORD OF CASE 60, MR. R.

Cultures were taken from curettings taken from pyorrheal pockets and from one root-tip. Both yielded a streptococcus viridans. One culture also contained the staphylococcus pyogenes albus. The streptococci formed green colonies on blood agar plates, formed acid and coagulated milk, fermented lactose and saccharose but none of the other carbohydrates. One of the original cultures was injected intravenously into an 800 gram rabbit which died the next day. It showed a marked hemorrhage into one of the mitral valve cusps and a number of whitish streaks in the myocardium, just beneath the pericardium. Microscopically, these streaks were found to be composed of lymphocytes gathered together in the cellular tissue beneath the pericardium. The streptococcus was recovered in pure culture and immediately injected in a smaller dose into another rabbit which died in two days, showing principally a deep congestion of the kidneys. Microscopically, the kidneys showed numerous small abscesses composed of polymorphonuclear cells.

Fig. 7

Showing area of hemorrhage in one of mitral cusps of a rabbit's heart after an injection of streptococci from case 60.

both in the medulla and the cortex as shown in fig. six. The streptococcus was recovered in pure strain from this rabbit.

The widespread infiltration of polymorphonuclear leucocytes shown in figures four and five are the product of streptococci taken from case number 59, that of a man forty-one years of age, white, unmarried, a painter by trade. At the present time he is suffering from arthritis deformans as shown in figures 8, 9, 10, 11, 12. He also exhibits myocarditis and a mitral insufficiency. He commenced to have rheumatism in his twentieth year and has been troubled by repeated attacks every few months during all the succeeding years until his joints are now in the condition shown in the radiographs submitted. During these years he has had a large amount of dental work done and when he appeared for treatment dental radiographs revealed the fact that there were abscesses in six or seven places in his mouth. There was also considerable pyorrhœa. The teeth were all extracted and the laboratory findings revealed as usual streptococcus viridans.

The dental radiographs submitted, Nos. 13, 14 and 15, give some idea of the condition in which we found the teeth. This patient made a marked improvement, which commenced almost as soon as the teeth were extracted. Though still in a crippled condition, the patient has insisted upon returning to work. The data here given shows clearly the possible damage to kidney tissues from this type of infection, as the blue areas in the cuts which were photographed through a dry lense, show numerous bacteria in the capillaries when examined through an oil immersion lense.

LABORATORY DATA ON CASE 59.

Cultures were taken from five root tips. All of these yielded a pure growth of streptococci. On blood agar plates two types of colonies were obtained, one surrounded by a greenish halo, the other remaining grey in color. Both streptococci were isolated in pure cultures. They presented the following features on routine media:

	Green	Grey
Agar	Thin, grey streak	Thin, grey streak
Milk	Acid	Acid, coagulated
Lactose	Acid	Acid
Saccharose	Acid	0
Mannite	0	Acid
Raffinose	0	0
Salicin	0	Acid
Inulin	0	0

A number of experiments were undertaken to demonstrate the pathogenicity of these bacteria. When massive doses were injected intravenously into rabbits,

Fig. 8

Showing arthritis deformans of foot of case 59.

both cultures caused death in 24 hours, apparently from toxæmia. In moderate doses (8cc. of a broth culture), death occurred in 48 hours.

The rabbit inoculated with the green strain showed a hemorrhage in one of the mitral cusps but no other gross lesions. The other rabbit showed multi-

ple minute abscesses throughout the kidney cortex. The streptococci were recovered in pure culture from the heart's blood of both rabbits, and after 24 hours incubation were reinjected into two new rabbits in 5cc. doses. Both of these rabbits died within 48 hours. The autopsy revealed no lesions save for a large number of miliary abscesses in the cortex of the kidneys. The streptococci were again recovered in pure cultures from the heart's blood and from the kidneys. These kidney lesions are shown in microscopic section in figures 4 and 5. They consisted of bacterial emboli in the capillaries of the cortex with surrounding areas of dense inflammatory infiltration, which usually consisted of polymorphonuclears but in some cases showed a predominance of lymphocytes. There is also a pronounced congestion of the kidneys as shown in figure 4.

Inoculated into the breast muscles of pigeons, the green culture produced an intense and widespread necrosis of the muscle without any inflammatory reaction, the pigeon dying within 24 hours. The gray culture produced no effect on the pigeon. In all of the animal experiments the organism was recovered at autopsy in pure culture and remained true, that is they showed no changes in morphology or cultural characters after animal passage.

In this case we have apparently obtained organisms belonging to the streptococcus viridans class which possess a high degree of virulence indicated by the rapidity with which they cause death and by the fact that they call out pus cells in the infected animals. These streptococci have shown a marked affinity for the kidneys, as there were no joint lesions and except for the one valve hemorrhage, none in the heart.

The bacteria which created the lesions in the medulla of the kidney shown in figure 6 were also obtained from dental abscesses and pyorrhœa pockets in the mouth of case sixty, the laboratory data of which has been given and who asked for treatment on account of

Fig. 9

Showing arthritis deformans of hand of case 59.

Fig. 10

Showing arthritis Deformans of hand of case 59.

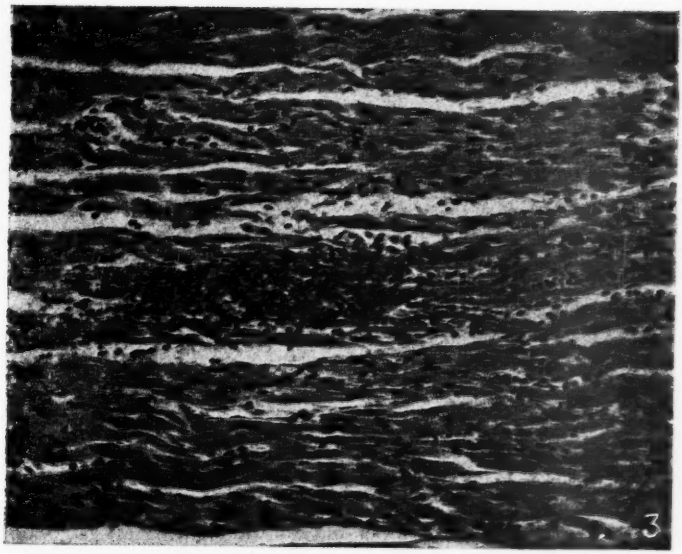


Figure 3

Acute myocarditis. Section of heart muscle from a rabbit which died 48 hours after an injection of streptococci from case No. 60. The section shows an area of lymphoidal infiltration.

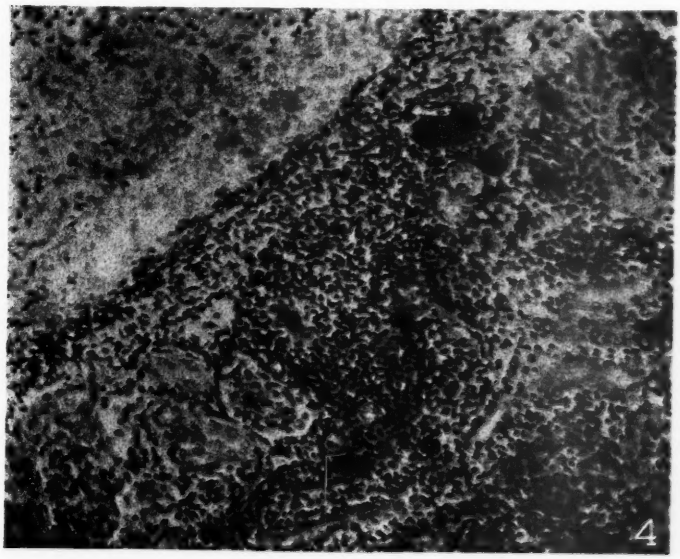


Figure 4

The section shows an area of wide-spread infiltration with lymphocytes and polymorphonuclear leukocytes in the kidney of a rabbit which died 48 hours after an injection of streptococci from case No. 59. This was the second passage of this streptococcus through rabbits.

a severe iritis which was causing him a great deal of distress and refused to yield to ordinary treatment. The finding of abscesses and pyorrhœa followed and immediate extraction was advised. To this the patient declined to submit and treatment for the iritis was persisted in, during which time the patient continued to suffer markedly until the teeth were extracted and the treatment of some of the worst pyorrhoeal pockets was completed, after which he commenced to make a marked improvement and refused further treatment.

Fig. 11

Showing arthritis deformans of elbow of case 59.

Fig. 12

Showing arthritis deformans of foot and ankle of case 59.

An examination of figure 7 clearly shows an area of hemorrhage in one of the mitral cusps of this rabbit's heart. Here we find an organism which produces a vigorous disturbance in the kidney within 48 hours and which also produces a severe lesion in the endocardium as well.

The clinical history of the individual who furnished the culture which produced figure 16 in research case No. 54, as follows: Mr. J. A. K.—Hospital No. 4076. He is a man of 73 years, male white, American, married. He has been an active worker all his life, his occupation being teamster. His best weight has been 165 pounds, present weight 149 pounds. He is a man of good habits and has endured many vicissitudes in his life.

In June, 1913, he began having swelling of the lower limbs and feet with accompanying joint tenderness and became weak physically as a result of his infection. His present complaints are swelling of the arms, hands, legs and feet, soreness and stiffness of the wrists. Findings: Anæmia, enlarged tonsils, pyorrhœa, arterio sclerosis, cardiac enlargement, both mitral and aortic systolic murmurs, stiffness of the spinal joints; in reality a picture of joint infection and old age combined.

The case is of intense interest because of the low grade type of infection, the rabbit dying one month after injection

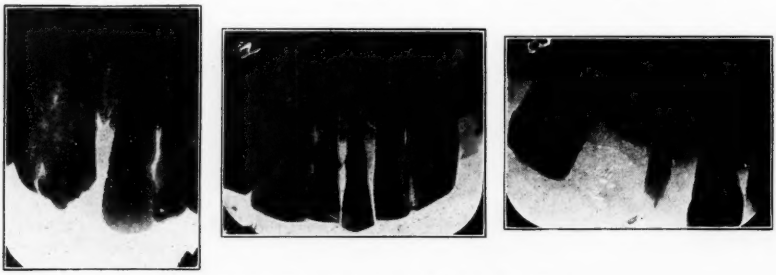
and the heart muscle showing a very diffuse infiltration of leucocytes.

LABORATORY FINDINGS AND ANIMAL EXPERIMENTS WITH MATERIAL FROM CASE NO. 54.

Cultures were obtained from four root-tips. In all of these streptococci belonging to the S. viridans group were obtained. One culture contained in addition the B. flourescens non-liquefaciens and the B. coli. Another culture was contaminated by the B. subtilis.

chamber of the eye of an etherized rabbit. At the end of 48 hours the eye was intensely congested and swollen and the anterior chamber was filled with pus. The rabbit was again etherized, a portion of the pus aspirated and cultures were made. These yielded a pure growth of streptococci. The broth culture from the eye was then inoculated into the peritoneal cavity of a rabbit. This rabbit died in 24 hours with general fibrinopurulent peritonitis and pericarditis. Again the streptococci was obtained in

Fig. 13 Fig. 14 Fig. 15



Illustrating the Condition of the Teeth in Case 59.

One strain which produced very long conglomerated chains was used for experimental work. It showed the following features:

Blood agar—Green colonies.
Broth—Sediment composed of large compact granules: No turbidity.
Milk—Acid, coagulated.
Lactose—Acid.
Saccharose—Acid.
Mannite—0.
Raffinose—0.
Salicin—Acid.
Inulin—0.

Inoculated intravenously in a massive dose this organism proved non-pathogenic. Its virulence was then increased by an ingenious method suggested to us by Dr. W. P. Larson, to whom we are indebted for many valuable suggestions. A s· all portion of the culture was inoculated through the cornea into the anterior

pure culture from the infected rabbit. One cubic centimetre of this culture was inoculated intravenously into a third rabbit, which died in three weeks. At autopsy this rabbit showed no gross lesions, but microscopically the heart muscle revealed the condition shown in figure 16, in which there is a well marked diffuse infiltration of lymphocytes between the muscle fibres.

The rabbit which had been injected in the eye died also after 24 davs. It showed a lesion of the aorta similar to that which we have described in case No. 52, but no other changes.

Figure 17, showing arterial infection, was created by the use of an organism obtained from research case 52, hospital No. 3020. Male, white, Scotch, 45 years of age, married, occupation—clerk in de-

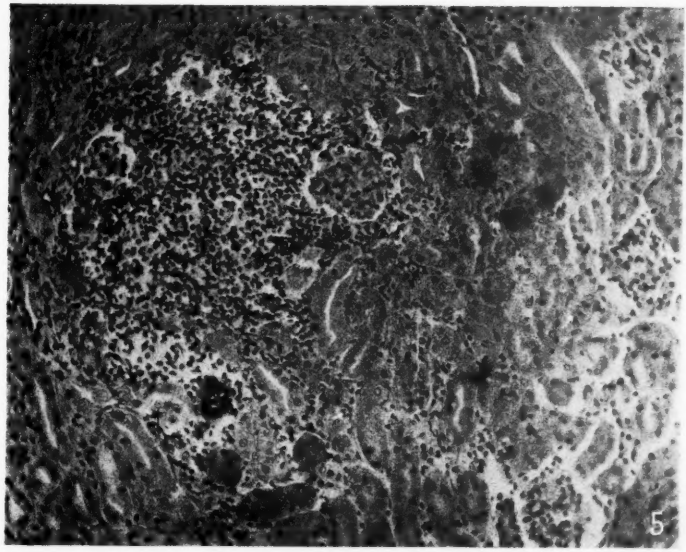


Figure 5

The section shows an area of polymorphonuclear infiltration in the kidney of a rabbit dying 48 hours after an injection of streptococci from case No. 59. The dark blue areas in both of the above sections are masses of bacteria which have lodged in the capillaries.

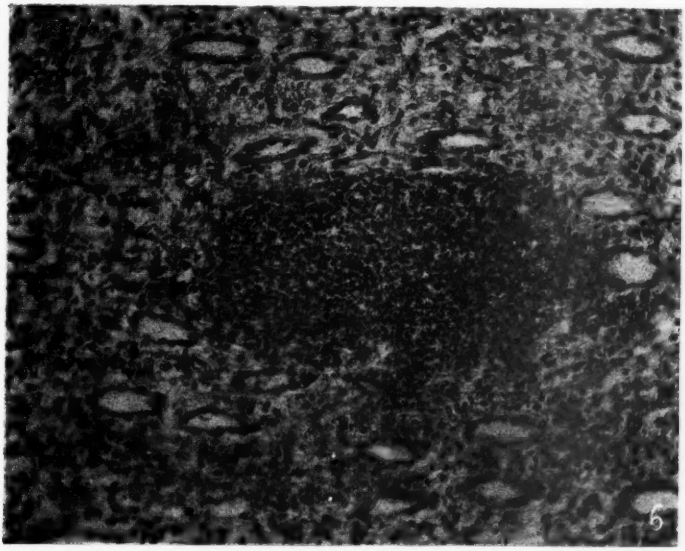


Figure 6

This plate shows a localized polymorphonuclear abcess in the medulla of the kidney of a rabbit which died 48 hours after an injection of streptococci from case No. 60.

partment store. He was admitted to the hospital Nov. 3, 1913. Diagnosis pyorrhœa, peptic ulcer, secondary anæmia. The blood count showed 4,176,000 red cells 76 per cent hæmoglobin, 6800 leucocytes. The gastric analysis showed a total acidity of from 89 to 97 acid per cent. Free HCL 26 to 39 acid per cent—no lactic acid and blood is present after the use of the stomach tube. Wasserman reaction, negative. Radiographic examination showed a large residue in the stomach six hours after Bismuth meal. He is troubled with a dull pain in his epigastric region, which would come on three or four hours after eating. As his bowels are constipated he attributes his pain to that fact. The patient has been in the habit of eating heavy foods after hard work. A year ago he became worse and began vomiting in the afternoons. The vomitus was blood. During the last three or four weeks prior to entering the hospital he became worse, with pain to the left of the umbilicus. December 16, '13, the teeth were cleansed roughly and some were extracted. December 18, '13, the root surfaces of the upper teeth were polished and the lower incisors were extracted. Gums much improved.

December 20 the lower teeth were polished. December 23 the mouth was in good condition except a pulp in left upper six, which was dead. February 3, '14, the disto-buccal root of left upper six was amputated, from which Henrici cultivated a culture for a vaccine. March 21, '14, he was given a prophylaxis and was injected with twenty millions of streptococcus viridans vaccine. Patient reported that he was able to be about but could not work. March 28, '14, patient reported that vaccine administered, thirty-five million, produced no unpleasant reaction. The vaccine was continued up to 150,000,000.

Fig. 16

Section of heart muscle of a rabbit which died one month after an injection of streptococci from case No. 54. The section shows a diffuse infiltration of the lymphocytes. This was the third passage of this streptococcus through animals.

LABORATORY DATA ON CASE 52.

Cultures were taken from one root-tip and its socket. In both cultures we obtained a growth of streptococci, together with the staphylococcus pyogenus albus and from the socket there was also obtained a small gram positive bacillus which has not been identified. The streptococci produced green colonies on blood agar plates. Culturally two types

were obtained. Their features are expressed below:

	A	B
Blood Agar	Green colonies	Green colonies
Milk	Acid, coagulated	Acid
Lactose	Acid	Acid
Saccharose	Acid	Acid
Mannite	0	0
Raffinose	0	Acid
Salicin	Acid	0
Inulin	0	0

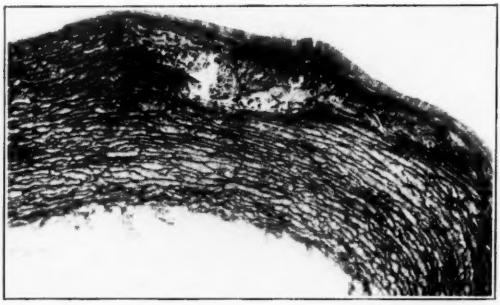
Four cultures were injected intravenously into rabbits. One rabbit died at the end of a month. Autopsy revealed no lesions either gross or microscopic. Another rabbit died after forty days. At autopsy there was found a marked roughening and puckering of the intimal surface of the ascending portion of the arch of the aorta. A section of this aorta, stained by Verhoeff's elastic tissue stain, is shown in figure 16. It shows an area of tissue destruction in the outer part of the media indicated by the breaking and twisting of the elastic tissue fibres at this point. There were a few lymphocytes in this area. There is a compensatory thickening of the intima over this area. We have observed similar aortic lesions in several other of our rabbits which have died some weeks after inoculation. We are not in a position to say that these lesions are caused by the inoculations of mouth streptococci, as vascular lesions are known to occur spontaneously in rabbits. We believe, however, that the occurrence of somewhat similar lesions in human cases of rheumatism is at least suggestive.

That the organisms from this case are of low virulence is indicated by the fact that several rabbits inoculated with this strain are still alive.

The patient has been discharged from the hospital and he is now feeling stronger and working vigorously out of doors taking any sort of food that he desires, though he declines to undertake indoor work.

Figure 17 shows a lesion in the arch of an aorta in which the intima is thickened with the destruction of the media, in a rabbit which died forty days after injection with streptococci from this peptic ulcer case. Doubtless those who are interested in this research will recollect that Rosenow has been able to produce peptic and gastric ulcer with a remark-

Fig. 17



Section of aorta of rabbit which died 40 days after injection of streptococci from case No. 52. The rabbit showed marked roughening of the ascending portion of the arch of the aorta. The section shows a destruction lesion in the media with a thickening of the over-lying intima.

able degree of regularity, with injections of certain strains of streptococci. We had hoped in this case that we would find gastric ulcer produced in our rabbits but instead we found arterial infections and no particular lesion of the intestinal or stomach mucosa.

Nevertheless, the thoughtful student in studying this series of lesions produced in strong healthy vigorous animals as a result of the inoculation with this common mouth organism, must naturally attach greater importance to the presence of such mouth infections than ever before and will doubtless, as do the co-laborers in this work, anxiously await further research with interest, for we believe that these experimental lesions point strongly to the probability that human lesions constantly arise from the same source and in like manner.

This paper is intended to be merely a preliminary report as the work is as yet incomplete and definite conclusions cannot be drawn. We intend in the future to continue to work along the same lines and also to conduct control experiments with healthy teeth. As was stated, we have already made cultures from seven teeth with healthy pulps, all of which proved sterile. We expect to control our animal experiments by examining a number of rabbits which have not been inoculated with streptococci in order to determine just what lesions occur spontaneously. Finally we intend to conduct a similar series of experiments with streptococci from normal saliva. Before this work is completed we do not feel justified in drawing conclusions from the laboratory work.

The following two are recent case records which we desire to append because we believe vaccines have been of service, stimulating continued repair after repair had ceased as a result of elimination of the local foci.

MR. C. J. B.—History.

Father and mother both living—nine children—five boys and four girls—all living and in good health except the patient himself.

Diagnosis made by Dr. Head:

Endocarditis of the aortic valve.

Aortic insufficienty.

Endocarditis of the mitral valve.

Mitral insufficiency or stenosis.

Marked cardiac hypertrophy with some dilatation.

Liver not enlarged.

Spleen not palpable.

Vessel walls slightly thickened.

Pulse regular—good volume suggestive of a water hammer pulse.

Capillary pulse present.

First attack of rheumatism was when he was sixteen years old, having fever and swelling of the joints. Knees have since troubled him. He was twenty-two years old at the time of the next attack and has had recurrent attacks every two or three years since. First had trouble with his heart when he was twenty-eight years old, since which time he has had a great deal. He had another severe attack during the past winter and had a great deal of discomfort with his heart. He has had professional care every time he has had an attack and his physicians diagnosed the case as being inflammatory rheumatism. He has taken the baths at Hot Springs and seemed to be helped by them but his trouble has always recurred.

After his twenty-eighth year, every attack has made him weaker. Before he was twenty-eight they did not seem to affect him physically as far as strength was concerned. He has not been able to do so much work since his twenty-eighth year.

First noticed dental abscess on March 25, '14, when radiograph was taken. Had tooth extracted April 1st. Started with

vaccine treatment April 7th. Subsequent treatments were given April 10, 15, 20, 24, 27, May 4, 7, 9, 11, 13 and May 16th. The vaccine dose has been slowly increased from three to 160 million, the injections numbering twenty-one in all, and were discontinued June 12, 1914.

The nodes which were on his fingers have entirely disappeared and the heart's action is much better. Patient has had exacerbation of tenderness in joints after vaccine but shows a steady gradual improvement and has been walking five to seven miles daily.

When first seen the patient walked slowly on account of soreness in his knees. He also had to rest when climbing stairs on account of his heart weakness. At present he has returned to his work as a railroad conductor.

MRS. K.

Age 54—Patient referred for treatment March 30, '14. On account of chronic articular rheumatism, principally of the knees, which on this date were increased in circumference more than two inches over normal, the circumference of the two knees being respectively 17 inches and 17¾ inches. Knees were tender to the touch and exceedingly painful, and gave forth a peculiar crepitus on movement which could be heard four linear feet from the knee. Patient gave a history of having had a two per cent solution of formaldehyde in glycerin in her knees one year earlier. This treatment caused most excruciating agony for three days, after which pain subsided and joints remained as sore as ever.

Careful radiographic examination of the mouth was made and an abscess involving the left lateral and extending into the neighborhood of the cuspid seemed to exist. This abscessed tooth had been treated June 23, 1913, at which time the tooth became comfortable and the root was then thoroughly filled. The radiographs showed the root filling to have extended through the end into the abscessed cavity for some distance. The gum was pink and healthy looking over the abscessed area and for all intents and purposes the result was all any one could desire. Nevertheless, in order to secure a culture for a vaccine to be used in the treatment of the rheumatism, the lateral was extracted and the root-tip nipped off with the protruding root filling and dropped into culture media, which promptly produced a growth of streptococcus viridans.

A vaccine was made and the first dose was administered April 10, '14, beginning with a small dose. The patient experienced a mild re-action the joint-tenderness increasing somewhat and there was slight malaise. On April 15, '14, the dose was doubled. Following this dose of vaccine the patient experienced a second re-action but appeared for a third injection on April 20, '14, at which time the dose was decreased one-third. On that day the patient was so unfortunate as to become chilled as a result of a ride of twenty miles. Following the chill a slight bronchitis developed and temperature rose to 103 degrees. The patient developed a typical case of peliosis rheumatica as described by Osler, large wheals appearing on the knees, legs and ankles from the size of a filbert to two and one-half and three inches in diameter, growing slowly red, then angry blue and slowly fading out in color, becoming dark blue, then yellowish green and at last disappearing altogether. The temperature during this time persisted from 103 to 104½ and the pulse rate rose to 130. The patient was kept extremely quiet and was given tincture of Nux Vomica, six drops four times a day.

The patient's appetite remained fairly good, taking three or four fresh raw eggs each day. The fever persisted for three weeks, slowly receding.

The swelling of the limbs entirely disappearing during this time, and the pain in the rheumatic joints also disappeared.

The patient grew stronger and was soon upon her feet. The pain and joint tenderness recurred in the knees but without swelling; accompanying the knee disturbance was shoulder and elbow swelling and tenderness and also some swelling in the fingers. Her improvement seemed to stop and it was thought best to commence a second course of vaccine and the cuspid adjoining the lateral socket was extracted on May 27th. From its root-tip a second culture of streptococcus viridans was obtained, the first dose of which, three million, was administered to the patient June 9th. The soreness in elbows, shoulders and thighs rapidly passed away. A second dose of seven million was administered June 13, at which time the patient reported absolute freedom from all pain and only slight tenderness in the knees on rising. The crepitus in the knees is almost gone. Cannot be heard except if one places the ear close to the knee joint when in flexion. The patient is now walking with a careless freedom unknown for the past three years and is in better health and spirits than she has been in that time.

Succeeding doses of vaccine were administered on June 18th, 23rd, and 26th. On the 26th all symptoms of pain, swelling and soreness are absent except one can on very close attention hear a slight crepitus at the knee joint and there is still a very slight soreness which seems to be rapidly disappearing.

BACTERIOLOGICAL TECHNIQUE EMPLOYED.

In the bacteriological technique employed, our attention was directed almost solely to the streptococci. There were two reasons for this. Firstly, streptococci were constantly present and frequently were the sole cultivable organisms obtained. Secondly, our immediate problem being the relationship of dental infections to rheumatism, it was thought that study of the streptococci would be most likely to yield tangible results. Other organisms, however, were noted in some of our cultures. On a number of occasions we obtained the staphylococcus albus; several times the B. coli and B. proteus were obtained, and in one culture the B. flourescens non-liquefaciens grew and in another the pneumococcus was obtained. For the most part our cultures were incubated ærobically. In several cases a parallel series of cultures were incubated anærobically, but the same results were obtained.

The cultures were incubated until a growth appeared, usually twenty-four to forty-eight hours. These cultures were then plated on blood agar; sheep's blood and rabbit's blood, in proportion of one cc. to ten cc. of agar were used for plating. After twenty-four hours, the colonies of streptococci appeared as small grey dots surrounded by a halo, which, by transmitted light had a green color. In some cultures colonies of streptococci appeared which produced no green halo; these we have called grey colonies. These two types of colonies are shown in figure one. Colonies were then picked to agar slants until a good growth had been obtained.

The cultural features of the streptococci were observed on eight routine media: blood agar, litmus milk, lactose, saccharose, mannite, raffinose, salicin and inulin broths. In the beginning of our work, the carbohydrate media were made by adding one per cent of the sugar used to plain broth tinted with litmus, a red color indicating acidity. Later in our work this medium was replaced by plain broth, which contained 33 1-3 per cent of beef serum, to which the various carbohydrates were added to the strength of one per cent and the acidity was determined by titrating against normal sodium hydroxide in the cold, using phenolphthalein as an indicator. This change was adopted because the streptococci grew very poorly in plain broth after one or two transfers

and it was thought that titration would yield more accurate results. The normal acidity of the media before inoculation was of course determined and deducted from the final result.

The table below indicated the cultural characters of thirty strains of streptococci from twenty-six cases. The table is necessarily incomplete as a number of our strains died after one or two transfers before they could be planted on routine media; so that in some cases only the action on blood agar was observed. Under the various sugars, the word acid indicates that litmus sugar broth was used and the litmus turned red. The figures indicate the amount of normal sodium hydroxide solution necessary to neutralize 100cc. of the sugar serum broth after it had been fermented by the streptococci.

	Blood Agar	Milk	Lactose	Saccharose	Manite	Raffinose	Salicin	Inulin
50	Green	No change	Acid	Acid	0	Acid	0	0
51	Green	Acid, Coag.	Acid	Acid	0	Acid	0	0
52a	Green	Acid	Acid	Acid	0	Acid	0	0
52b	Green	Acid	Acid	Acid	0	0	Acid	0
54d	Green	Acid, Coag.	1.8	0.9	1.2	0	4.5	0
54e	Green	Acid, Coag.	2.0	1.5	2.1	1.3	3.7	0
55	Green	Acid, Coag.	Acid	Acid	0	Acid	0	0
56	Green	x	x	x	x	x	x	x
59a	Green	Acid, Coag.	2.2	1.5	2.7	1.7	2.8	0
59b	Grey	Acid, Coag.	1.2	1.4	2.4	1.3	2.5	0
60	Green	Acid, Coag.	1.2	0.8	2.2	1.7	2.7	0
61	Green	Acid, Coag.	x	x	x	x	x	x
62	Green	Acid, Coag.	1.8	0.6	2.2	1.7	2.6	0
63	Green	x	x	x	x	x	x	x
64	Green	Acid, Coag.	1.8	0.7	2.3	1.8	2.6	0
65	Green	Acid	0.4	0.9	2.0	0.7	1.4	0
61	Green	Acid	x	x	x	x	x	x
68a	Green	Acid, Coag.	x	x	x	x	x	x
68b	Grey	Acid	1.6	1.4	2.8	1.7	2.6	0.2
69	Green	x	x	x	x	x	x	x
70	Green	No change	1.2	0.6	1.8	1.4	1.2	0
71	Green	Acid	0.7	0.8	2.4	1.5	2.5	0
72	Green	x	x	x	x	x	x	x
74	Green	Acid, Coag.	x	x	x	x	x	x
75	Green	x	x	x	x	x	x	x
76	Green	Acid, Coag.	x	x	x	x	x	x
78	Green	No change	x	x	x	x	x	x
79	Green	x	x	x	x	x	x	x
82	Green	Acid, Coag.	1.4	1.7	3.1	1.8	2.8	0
83	Green	Acid, Coag.	1.0	1.1	2.4	2.9	2.6	0

Owing to the existing confusion in the classification of streptococci, it is somewhat difficult to interpret the findings detailed above. The production of a greenish halo around the colonies on blood agar plates undoubtedly places our organisms in the class which Schottmüller has designated the streptococcus viridans. It is generally conceded that the name "streptococcus viridans" designates, not a distinct species but a group, in which there are several varieties differing considerably in their pathogenic and powers of fermentation. It seemed to us important to attempt to identify our organisms either as S. salivarius, constantly present in the mouth and generally considered non-pathogenic, or as S. mitis, commonly associated with endocarditis and similar rheumatic infections. To this end we have accepted the classification of Andrews and Horder, who state that S. salivarius ferments lactose, saccharose and raffinose, not salicin and that the S. mitis ferments lactose, saccharose and salicin and not raffiinose. In our earlier work using litmus

sugar broths some strains apparently fermented raffinose and some salicin. Later, using serum sugar broths and determining the acidity by the more delicate method of titration, it was found that our streptococci produced some acid both in raffinose and salicin but that in almost every case there was considerably more acid produced from salicin than from raffinose. We feel justified therefore, in either classifying our organism as S. mitis or in placing them in a special group midway between the two species. Indeed, this latter position appeals to us more strongly, for we believe although we have as yet performed no experiments toward proving it, that these organisms represent members of the common S. salivarius class, which, under favorable conditions of bad mouth hygiene and dental decay gain entrance into the deep peridental tissues and there take on new properties both as to pathogenicity and as to cultural characters. Two facts stand out prominently from our work so far: members of the streptococcus viridans group are constantly present in dental infection and the common pus-producing hæmolytic streptococci are constantly absent.

In our animal experiments rabbits were used exclusively, being more susceptible to streptococci than the other laboratory animals. For the same reason young rabbits weighing between 800 and 1000 grams were used as far as possible. Inoculations were made, with few exceptions, into the marginal ear vein. The results of these experiments are summarized below:

Case 50—Two cc. of a twenty-four hour broth culture were injected intravenously in February 9, '14. The rabbit died on March 25, '14. The autopsy revealed no gross lesions. Blood cultures remained sterile. Microscopical examinations were made of the heart and kidney, both appearing normal.

Case 51—Two cc. of a twenty-four hour broth culture were injected intravenously on February 9, '14. The rabbit died on March 17, '14. The autopsy revealed no gross lesions. Microscopically the heart appeared normal. The kidney showed patches of degeneration in the cortex (cloudy swelling.)

Another strain from the same patient was used to inject a second rabbit on February 5, '14. The rabbit died on March 17, '14. The autopsy revealed a marked roughening and puckering of the ascending arch of the aorta and some cardiac hypertrophy. Sections of the aorta showed a thickening of the intima in patches and at one point a collection of lymphocytes deep in the media. The heart and kidney appeared normal in microscopic section.

Case 52—In all, seven rabbits were inocculated with various strains of streptococci from this case. Five of these are still alive. One rabbit injected intravenously with 2cc. of a twenty-four broth culture on February 17, '14, died on March 20, '14. The autopsy revealed no gross lesions and the blood cultures remained sterile. The heart and kidney showed no microscopic lesions. Another rabbit injected on the same day died on March 28, '14. At autopsy the ascending portion of the arch of the aorta showed a marked roughening and puckering with several small altheromatous ulcers. Microscopically the aorta showed areas of degeneration in the media, the elastic fibres being broken and twisted, with a few scattered lymphocytes. The overlying intima was hypertrophied. The heart muscle showed a marked diffuse infiltration of lymphocytes.

From these experiments it was concluded that the organisms had a very low virulence for rabbits as the animals lived a relatively long time after injection. On February 24, '14, two rabbits were inoculated with much larger doses. Twenty-four hour cultures from cases 51 and 54 were used. Forty cc. of the broth was centrifuged, the broth poured

out and the sediment injected into the marginal ear veins. The rabbit inoculated with culture 51 died on March 20, '14. The autopsy revealed no gross lesions and the blood cultures remained sterile. The other rabbit is still alive.

We next attempted to raise the virulence of some of these strains of streptococci by Larson's method. A few drops of a twenty-four hour broth culture were injected into the anterior chamber of the eye of an etherized rabbit. In two days the eye was deeply congested, the anterior chamber was filled with pus and the periorbital tissues markedly infiltrated. Under ether anæsthesia, a needle was plunged into the eye, some of the pus withdrawn and plated on blood agar. It yielded a pure growth of green streptococci. From these plates sub-cultures were made, and five cc. of a twenty-four hour broth culture was injected intraperitoneally into a second rabbit on March 10, '14. The rabbit died in twenty-four hours with a general fibrino-purulent peritonitis and pericarditis. Cultures from the peritoneal fluid and heart's blood again yielded streptococci, which produced green colonies on blood agar. A third rabbit was injected intravenously with one cc. of a twenty-four hour culture from the second rabbit. Contrary to our expectations, this rabbit did not die until April 5, '13. The autopsy revealed no gross lesions and cultures remained sterile. Microscopically there were found occasional small areas of lymphocytic infiltration of the heart muscle and larger areas of similar infiltration in the kidney. The latter areas were arranged in radial streaks, apparently in a perivascular position and were found principally in the medulla. The rabbit injected into the anterior chamber of the eye also died March 28, '14. The autopsy showed no gross lesions save an irregular puckering in the ascending portion of the arch of the aorta such as has been already described.

Case 55—Two rabbits were injected on February 24, '14. Each animal received the centrifuged and washed bacteria from 40 cc. of broth. One animal developed convulsions during the injection due to air ebbolism and died the next day. The streptococci were recovered from its blood after death, and on March 20, '14, 5 cc. of a broth culture of this strain was used to inoculate another rabbit. This animal died on April 17, '14. The autopsy revealed no gross lesions and blood cultures remained sterile. Microscopically, the heart and kidneys appeared normal. The first rabbit which received a massive dose on February 24, '14, died March 12, '14. At autopsy there was found a well marked chronic myocarditis, the heart musole showing numerous white streaks and spots. Microscopically, these were found to consist of fibrous connective tissue some areas containing several large endothelial giant cells. The kidneys showed a number of small areas of lymphocytic infiltration irregularly scattered through the cortex. Both knee joints of the hind legs were filled with a glairy fluid which microscopically showed a number of polymorphonuclear leucocytes. No organisms were found and cultures remained sterile.

Case 59—Two strains of streptococci were used, one, 59a, produced green colonies on blood agar, the other, 59b, produced grey colonies with no change in the medium. Two rabbits were inoculated March 6, '14, with the centrifuged and washed bacteria from 100 cc. of dextrose serum broth, receiving one-half intravenously and the remainder intraperitoneally. Both rabbits died within twenty-four hours; apparently from toxemia. Two rabbits were again inoculated with the two strains of streptococci on March 18, '14, each receiving 8 cc. of a twenty-four hour broth culture intravenously. Both rabbits died on March 20, '14. Rabbit 59a showed a small hemorrhage into one of the cusps of the mitral

valve, and numerous small white areas in the cortex of the kidneys. Microscopically, the heart muscle showed a number of small discrete nodules of lymphocytic infiltration. Sections of the kidney showed occasional masses of bacteria in the glomeruli and small capillaries and numerous large areas of inflammatory infiltration throughout the cortex; these areas contained both lymphocytes and polymorphonuclear leucocytes, the the lymphocytes predominating. Streptococci, which produced green colonies on blood agar, were recovered from the heart's blood and on March 23, '14, 5 cc. of a twenty-four hour broth culture were injected intravenously into another rabbit. This rabbit died on March 24, 14. At autopsy there were found a number of miliary abscesses throughout the kidneys both in the cortex and medulla. These abscesses contained polymorphonuclear leucocytes only and frequently showed bacterial emboli in or near them.

Rabbit 59b also showed numerous miliary abscesses throughout the kidneys, particularly in the medulla, where bacterial emboli were found in the capillaries and perivascular areas of lymphocytic and polymorphonuclear leucocytes were found. Cultures yielded streptococci. Five cc. of a twenty-four hour broth culture of this strain was injected into another rabbit, which is still alive.

On March 18, '14, two pigeons were inoculated with the two strains of streptococci, each receiving 5cc. of a twenty-four hour broth culture into pectoral muscles of the right side. Pigeon 59a died within twenty-four hours, showing complete necrosis of the muscles of the side with large masses of bacteria infiltrating between the fibres in all directions. Pigeon 59b is still alive.

Case 60—A rabbit received 10 cc. of a twenty-four hour broth culture into the marginal vein of the ear, March 20, '14, and died March 22, '14. There was a large hemorrhage into one of the mitral cusps, with numerous small white streaks beneath the pericardium of the left ventricle. The streaks proved to be aggregations of lymphocytes. Miliary abscesses containing polymorphonuclear leucocytes were scattered through both kidneys. Streptococci were recovered from the heart's blood and on March 23, '14, another rabbit was injected with 5 cc of a broth culture. This rabbit died on March 25, '14. Again miliary abscesses were found in the kidneys, although fewer in number. No heart lesions could be demonstrated.

It is evident from these experiments that we are dealing with organisms of low virulence. Some of our animals did not die at all and most died a relatively long time after inoculation. Of the animals that died, the most striking features were a progressive emaciation and loss of strength; characteristic lesions, particularly in the joints were disappointingly absent. The lesions which we obtained, however, were those of the heart, kidneys and arteries, lesions frequently associated with human rheumatism. Save for two cases of hemorrhage into the heart valve we have never found anything approaching an endocarditis. In several cases, however, we have obtained distinct myocardial lesions. These consisted in either a diffuse infiltration of lymphocytes, in submiliary nodules composed of aggregations of lymphocytes or in areas of fibrosis with occasional giant cells. The lesions we obtained were practically identical with those obtained by Liela Jackson in experimental inoculations of rabbits with streptococci. The kidney lesions have consisted of abcesses, which contained either polymorphonuclears alone or associated with lymphocytes, and which in some cases contained bacterial emboli, or in small aggregations of lymphocytes along radial vessels of the medulla quite similar to those recently described by Le Count as occurring in the kidneys of rabbits which had

received experimental inoculations of streptococci. The arterial lesions which occurred in three cases were destructive lesions of the media of the aorta in the ascending portion of the arch, with a hypertrophy of the overlying intima. We admit that these lesions may be spontaneous but in view of the recent work by Klotz on arterial lesions in rheumatism and experimental streptococcus infections, we feel justified in presenting them here.

That we have to do with organisms of low virulence is further indicated by the fact that the size of the dose injected had little effect on the final results: the bacteria from 40 cc. of broth killed no more quickly than from 5 or 10 cc. Extremely large doses, as was to be expected, killed by toxemia alone.

That our streptococci are potentially virulent, however, is indicated in the experiment where they were injected into the anterior chamber of the eye. Here, growing a closed chamber in an animal fluid which contains no anti-bodies, the organisms took on a degree of virulence characteristic of hæmolytic streptococci, without, however, undergoing any changes either in morphology or in cultural characteristics.

REFERENCES.

1. Andrews and Horder. Lancet. 1906. 11, 1415.
2. Lieia Jackson, Jour. of Inf. Dis. XI, No. 2, 243-252.
3. Le Count, Paper read before the Toronto meeting of the Amer. Assoc. of Pathalogists and Bacteriologists, April, 1914.
4. Klotz, Rheumatic Fever and the Arteries. Transactions of the Amer. Assoc. of Physicians, 1912.

The director of this research gratefully acknowledges many valuable suggestions from Dr. Edward C. Rosenow.

Sept. 19th, 1914.

Since the above report was written and transmitted to the National Association, we have examined the hearts, kidneys and large blood vessels of sixteen healthy rabbits and have been unable to find in them, lesions of any sort.—T. B. H.

METALLURGICAL, PHYSICAL, AND ELECTRO-CHEMICAL RESEARCHES

By Weston A. Price, M. S., D. D. S., and Frank A. Fahrenwald, E. M., M. S., Cleveland, Ohio

(Read before the National Association at Rochester, N. Y., July 7, 1914.)

SPECIAL studies have been made in these departments under the following subjects:

METALLURGY

(1) General Review and Classification of the Available Literature of all Metallurgical Departments of Science and Art.

(2) Collection and Condensation of Data likely to be Required and Helpful in Future Dental Metallurgical Researches.

(3) Researches for finding Substitutes for Iridio-Platinum for Crown Posts, etc.

(4) For substitutes for Platinum Foil and for new Backing Metals.

(5) For new metal for making rigid Structure Frames of sufficient rigidity to prevent contraction distortion of Gold when casting.

PHYSICS

Repeating for correcting and checking studies of the physical properties of inlay and impression waxes, to determine particularly.

(1) Dimension Changes with Temperature.

(2) Elasticity.

(3) Practical Effects and Application.

ELECTRO-CHEMICAL

Studying the battery effects of various metals and combinations of metals.

(1) In Normal Saliva.

(2) In Acid Saliva.

(3) Alkaline Saliva.

METALLURGY

The special researches being conducted for the Commission during the past year in thes departments have been carried on in Cleveland and largely in the various departments of Case School of Applied Science, which privileges have been placed, gratuitously, at the disposal of the Commission. These facilities have included the exclusive use of a private room equipped for general metallurgical researches, with the privilege of access to, and use of, the large quantity of microscopic, and photographic apparatus of their extensive metallurgical department. Also the use of special apparatus of the Electro-Chemical and Physical Departments. We are greatly indebted, for material, assistance and counsel, to Dr. Charles H. Fulton, head of the Department of Mining Engineering and Metallurgy; Dr. Albert W. Smith, head of the Department of General Chemistry; Dr. W. R. Veazey, head of the Department of Electro-Chemistry, and Professor Dayton C. Miller, head of the Department of Physics.

Having as our task the problems outlined above, we were immediately embarrassed from the fact that there was very little dental metallurgical literature and almost none bearing directly on the metallurgical problems in hand. It became necessary, therefore, to acquaint ourselves with the literature on these subjects and to make a reference index to it in order that we might avoid duplicating, unnecessarily, researches that had already been recorded. This entail-

ed an enormous amount of work, which fell almost entirely upon our competent associate, Mr. Fahrenwald. It envolved the collection of data on the properties of practically all the metals that might have been available in solving the problems with which we were engaged. A great deal of this data is put in definite and permanent form and so completely condensed as to be included in the table known as Figure No. 3 in this text. By carefully studying the key any student can readily ascertain the general effect, as expressed in physical properties, of each of the most available metals when melted with one of the others, hence the available binary alloys.

It has been our purpose to so present the result of these studies, of various combinations of meals, that the charts would carry the information that will be desired for other metallurgical problems as they may arise in dentistry, and while many of the combinations here illustrated are not available for the special purposes for which they were studied, they may be for others, and their retention, in the files of the members of the profession, should be of great value to many.

There are probably no metallurgical problems, confronting the dental profession, of so great importance as the finding of substitutes for the platinum alloy which will be both stronger and much less expensive. It has been stated by a good metallurgical authority that one-third of the platinum used in the world today is used in the arts. and science of dentistry, variously estimated around one and one-half millions of dollars worth per year. The reasons for its use in dentistry is not based on the same kinds of standards that have brought it into use in jewelry. It is because platinum alloys will stand high temperatures, are not oxidized, will receive the alloys of gold as solders, are not effected by the fluids of the mouth, do not lose their stiffness entirely when heated, the coefficient of expansion corresponds to that of porcelain, etc. It is clearly evident that if metals can be produced, furnishing these physical properties at a fraction of the expense of platinum, they will afford a great saving to mankind and to our profession, and if it can be that they shall have these desirable physical properties in greater degree, they will become just so much more to be desired. Inasmuch as the gold solders require a base of higher melting point than silver, and one with which they will unite, the qualities of the class of material that will be desired for backings and foil will differ chiefly from the metals to be used for post materials, in that they will require to be soft, or medium soft, while in the latter they will require to be very stiff, even after heating. These two problems are, therefore, so closely related that they will be studied together. Before studying alloys in detail we should note some of the characteristic physical properties of the available metals, which are shown in Figure No. 1. In these studies the Centigrade temperature unit will be used, assuming that the dental profession is ready to adopt that temperature scale in harmony with general science. You will kindly note in this table, Figure 1, the relative melting points, Centigrade, Silver 961°; Gold 1063° (1945° Fahrenheit); Copper 1084°; Palladium 1550°; Platinum 1755°; Molybdenum 2500°; Tungsten 3000°. Inasmuch as one of our constant embarrassments in dental metallurgical work is that of the contraction of the metals, we should note the difference in coefficient of linear expansion of these metals, which is nearly four times as great per degree with gold as for molybdenum, but since the rate of coefficient of linear expansion of gold increases rapidly as we approach its melting point, the difference in dimension change through the same range of temperature for these two metals is about six times as great for gold as for molyb-

Figure 1

Metal	Melting Point. °C	Boiling Point. °C at 760	Coefficient of Linear Expansion	Tensile Strength Lbs.-sq.in.	Density[1]	Atomic Weight O=16.	Atomic Volume
Aluminium	657.3	1800.0	2550. x10^{-8}		{ 2.58 2.62	27.1	10.4
Antimony	630.5	1440.0	976. x10^{-8}	[2] 1000.0	{ 6.71 6.62	120.2	18.1
Barium	850.0	1580.0	———	———	3.78	137.37	36.6
Bismuth	268.0	1935.0	1575. x10^{-8}	[3] 3000.0	{ 10.00 9.90	208.0	21.2
Cadmium	321.0	778.0	2879. x10^{-8}	———	{ 8.64 8.69	112.4	13.0
Caesium	2637	———	———	———	{ 1.88 1.88	132.81	70.6
Calcium	780.0	———	———	———	1.57	40.09	25.2
Cerium	623.0	———	———	———	7.04	140.25	19.9
Chromium	1489.0	2200.0	———	———	6.92	52.10	7.5
Cobalt	1480.0	———	1234. x10^{-8}	———	8.70	58.97	6.7
Copper	1084.0	2310.0	1669. x10^{-8}	[4] 50000.0	{ 8.91 8.93	63.57	7.1
Gold	1063.5	2200.0	1390. x10^{-8}	[5] 20000.0	{ 19.33 19.31	197.2	10.2
Indium	155.0	———	4594. x10^{-8}	———	7.42	114.8	16.1
Iridium	2292.0	———	648. x10^{-8}	———	22.42	193.1	8.6
Iron	1520.0	2450.0	1110. x10^{-8}	[3] 35000.0	{ 6.97 7.02	55.85	7.1
Lead	326.9	1525.0	2756. x10^{-8}	[4] 2800.0	{ 11.37 11.37	207.10	18.2
Lithium	186.0	———	———	———	0.59	7.0	11.8
Magnesium	651.0	1120.0	2541. x10^{-8}	———	1.74	24.32	13.9
Manganese	1207.0	1900.0	———	———	7.39	54.93	7.4
Mercury	-38.85	357.0	———	———	{ 13.69 14.19	200.0	14
Molybdenum	2500.0[2]	———	360. x10^{-8}	[3] 80000.0	9.01	96.0	10.6
Nickel	1450.0	———	1357. x10^{-8}	[3] 55000.0	{ 8.71 8.90	58.68	6.5
Osmium	2700.0[2]	———	678. x10^{-8}		22.48	190.9	8.4
Palladium	1500.0	———	1175. x10^{-8}	[3] 30000.0	11.9	106.7	8.9
Potassium	62.5	667.0	8300. x10^{-8}	———	{ 0.83 0.87	39.10	45.9
Platinum	1755.0	———	982. x10^{-8}	[3] 50,000.0	{ 20.00 21.50	195.0	9.06
Rhodium	1907.0	———	858. x10^{-8}		12.1	102.9	8.5
Silver	961.5	1955.0	1846. x10^{-8}	[3] 40000.0	{ 9.50 10.50	107.88	10.2
Sodium	97.0	742.0	7200. x10^{-8}	———	{ 0.92 0.97	23.0	24.1
Thallium	303.7	1280.0	3135. x10^{-8}	———	11.85	204.0	17.2
Tin	232.0	2270.0	2138. x10^{-8}	[4] 6000.0	{ 6.97 7.29	118.0	16.3
Tungsten	3000.[2]	———	884. x10^{-8}	[3] 600000.0	18.7	184.0	9.8
Zinc	419.0	918.0	2835. x10^{-8}	[4] 6500.0	{ 6.76 7.10	65.37	9.2

1. Cast Metal
2. Rolled Metal
3. Upper figure refers to liquid state; lower to solid state.

deum. You will also please note, under the tensile strength in pounds per square inch, the very great variation ranging from twenty thousand pounds for gold and fifty thousand pounds for platinum to three hundred thousand pounds for tungsten. This table should be of very great help for frequent reference. In making these studies we have constantly had in mind the embarrassment, above referred to, namely, that our profession has continually had difficulty in making cast reproductions which are not distorted because of the contraction of the metal envolved. This applies as surely to metal when fused under the blowpipe as in the construction of bridges by the ordinary methods, as all bridge workers know, and we have hoped to find either structure materials of sufficient strength, that a frame work into which gold would be cast would hold it from distorting, or, if possible, we might find an alloy which would have little change between the fluid state and normal temperature. These dimension changes of gold with its change of temperature, both from the molten state to its first crystaling form, and from this to normal temperature, were previously very exhaustively studied and reported.* These studies demonstrated that gold changed its dimensions in passing from normal temperature to its last crystaling form, before going into solution, 2.2% linear or 6.6% volume, (volume dimension equals three times linear dimension) and from its first crystaling form to a liquid state, with a change of temperature of less than one degree, it undergoes a dimension change of 1.9% linear or 5% volume, making a total change from its liquid state to normal temperature of 11.53% volume, which is the amount that water changes in passing from the liquid to the crystalline form but in the opposite direction. That this contraction quality of gold is an exceedingly constant embarrassment is demonstrated by the fact that so far as we know few, if any, members of the dental profession are able to make cast reproductions that are actually quite close in dimension to the size of the pattern with which they started. This will be discussed in the report of physical researches.

Our chief metallurgical researches have centered around the problem of finding an inexpensive metal, or combination of metals, that would be eminently suitable for the posts for crowns and for bridge supports, having all the desirable properties of iridio-platinum, and as many of these in greater degree as possible.

Mr. Fahrenwald has expressed these qualities, and the approach to the solution of these problems, in his laboratory notes as follows:

A material suitable for this purpose must meet the following requirements:

1. The melting point, if gold is to be the soldering material, should be above at least 1200 degrees C.

2. The material must be unaffected by the chemical compounds of the mouth, and should not oxidize at a soldering temperature.

3. It must possess sufficient strength to resist stresses tending to change its form while in place, and at the same time be sufficiently malleable and ductile to permit of its being worked to the required shape.

4. The coefficient of expansion must be small in order to easily produce desired dimensions in the finished work. (This is not important for a simple post where gold is cast or fused about it at one point as a cast crown base.)

5. It should be of such material as will solder readily with the filling material; in most cases, gold.

6. The cost of production, when compared with platinum-iridium, must be low.

*Weston A. Price, Dental Cosmos, March 1911, "The Laws Determining the Behavior of Gold in Fusing and casting."

Reviewing briefly the materials at present available: Condition 1 is met by all metals having a melting point above that of gold. In order to fulfill conditions 1 and 2, many of these are eliminated. Taking 3 also into consideration, there remain only a few which meet to a greater or lesser degree the first three conditions. These are, in the order of their melting points: nickel, 1452; cobalt, 1490; chrominum, 1510; iron, 1520; palladium, 1550; platinum, 1755; iridium, 2300; molybdenum, 2500, and tungsten, 3000. Introducing conditions 4 and 5 also, there remains only platinum, which, to a greater extent than any other single element, meets all of the above conditions. But, even platinum is not sufficiently strong to withstand stresses involved during casting and later, while in place. This difficulty to a certain extent, has been overcome by the addition to the platinum of about 10% of iridium, which, however, makes the material even more expensive.

In view of the fact that no other single inexpensive metal is suitable, it is evident that further search for the desired material must lie within the realm of alloys; for if the proper combination can be evolved, of two or more of the above named metals, or any of the above with any metallic or non-metallic element, a very desirable material will result; as in the parallel case of the addition of small amounts or carbon to iron, forming steel. As in this instance, the physical properties of many metals may be radically changed by the addition to it of varying amounts of another element, or of several elements. This then admits to the list of possibilities other metals whose properties may be sufficiently modified in alloying; among them: silver, gold, copper, tin, zinc.

Before attempting a solution of this problem it was necessary to review all available literature referring to any work already done in studying the alloys and allowing properties of all elements which might find application in this work. Most of the material given, however, does not include information concerning such physical properties as are desirable in the material for which we are seeking. However, much work in the line of thermal analysis has been done, and in the diagrams of thermal equilibrium which will be given, the proportion and type of the different constituents of a series of alloys may be very easily detected.

The relation between the constitution of an alloy and its mechanical properties, is rather well defined, as will be shown later, and so it is possible to a certain extent, from a study of a certain equilibrium diagram, to interpret in terms of characteristic mechanical properties, the terms given as constituents. In turn, the general properties, the terms given as constituents. In turn, the general properties of these constituents are often determined by those of their components, which are some form of the elements themselves.

For this reason, and in order to proceed in a proper manner with this work, certain established laws must be obeyed and the relation of the various elements to each other recognized. For those of the Dental profession who may be interested in following this investigation work, but who are not metallurgically inclined, the following general outline of certain governing factors, is included.

THE ELEMENTS

In 1864, Newlands observed that if the elements were arranged in the order of their atomic weights, similar elements occurred at approximately equal intervals. On account of the inaccuracy of the atomic weight determinations made at that time, the true regularity and relationship was not given the table constructed by him. The present form of the periodic table is due to Mendeléef and Lother Meyer, who later, with more accurate data at hand, arranged the elements in such manner that their remarkable relationship is clearly shown.

Fig. 1 shows a table constructed in this manner. Several elements, not of metallurgical interest at present, have been omitted, so that the arrangement given allows for a better comparison of the metallic elements than does the complete chemical table.

Beginning at the upper left corner, the atomic weights show an almost uniform increase, when read from left to right in a transition group of three elements. Within any one group there is no sudden change in general chemical properties when passing from one element to the next in order.

Reading from left, thru any one group, the first is strongly base forming, and the last is strongly acid forming, while those intermediate may be either, depending upon their relative positions.

Figure 2

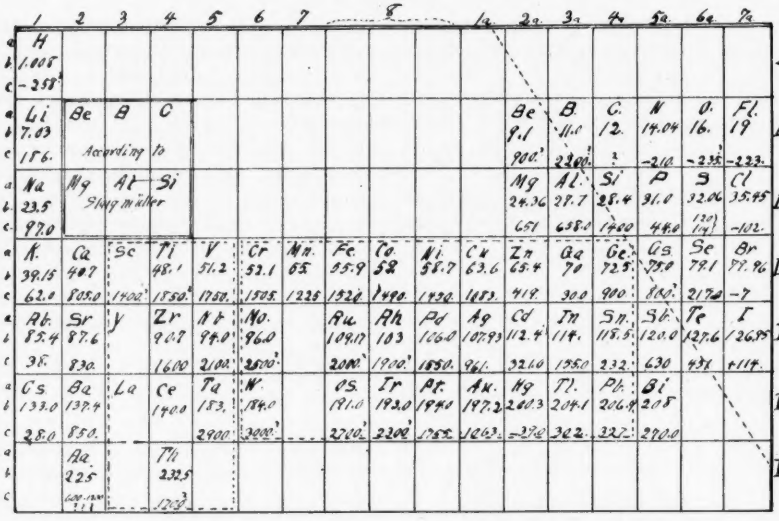


Fig Periodic Table showing relationship of more common elements (According to Werner.)
a = Symbol for the element.; b = atomic weight; c = melting point.

succeeding groups. Hydrogen, with an atomic weight of 1.008, is placed in group I. Lithium, with an atomic weight of 7.03, comes first in group II; then follow berillium, 9.1; boron, 11; carbon, 12; nitrogen, 14.04; oxygen, 16.; and flourine, 19.0. Then in group III, sodium, 23.5; magnesium, 24.36; and in similar succession until thorium, with an atomic weight of 232.5, is reached. The horizontal rows represent periods or groups. A complete group contains seventeen elements arranged in two series of seven each, with Considering the two series forming one group; the first begins with elements which are strongly base-forming, and ends with strongly acid forming elements; e. g., potassium of column 1 and manganese, column 7. The second (sub. "a") series begins with elements which are only moderately base forming and ends with markedly acid forming elements; e. g., zinc in 1a, and bromine in 7a of the same group. The elements (8) connecting these series are intermediate, in their behavior, between the ele-

ments they connect; those of the first verticle column (iron, ruthenium, osmium,) forming both acids and bases; the others forming only acids.

However, in passing, with consecutive readings, from one horizontal group to the next lower, there is a sudden change in the chemical properties of elements of consecutive atomic weights. Thus, the last element of group II, flourine, with an atomic weight of L9.0, is in complete contrast, in its chemical nature, to the next element sodium, with an atomic weight of 23.5, and which belongs in group III. Also, ionine, the last member of group III forms powerful acids, while caesium, the first member of group IV, is one of the most powerful base forming elements known.

Considering now the elements in a vertical column it is found that they are, on the whole, such as would naturally fall together in a classification of the elements according to their general chemical properties. Thus in first column are lithium, sodium, potassium, and caesium, —metals of the alkalies; in the second column are calcium, barium, and strontium,—metals of the alkaline earths, and so on.

It will be observed that the numbers of the columns of the table are repeated, running from one to eight and then beginning with 1a. There are, therefore, two columns represented by similar numbers. Between the like members of these two columns there is a general similarity of properties, although it is not so great as between members of the same column. Thus, the compounds of vanadium, niobium, etc., in column 5, bear considerable resemblance to those of phosphorous, arsenic, etc., in 5a. The especial property which is the most striking example of this, is that of the valency, or combining power of the elements. All the elements, of the two columns indicated by the same number, form in general, compounds of precisely the same formulæ. Take, for instance, the highest oxides of the two columns 5 and 5a. These are:

5 V_2O_5—Nb_2O_5—Ta_2O_5

5a N_2O_5—P_2O_5—As_2O_5—Sb_2O_5—Bi_2O_5

This holds good for the other columns, each pair having its own combining capacity, which increases regularly from 1 to 8 and from 1a to 8a. The same sort of regularity appears in the case of chlorides, bromides, etc.

It is time thus seen that from a chemical point of view the elements of a vertical column are very similar, and there is no radical change in the properties of consecutive elements of a group. It is therefore evident that there should be a general similarity among the elements grouped in any one part of the table. The rectangle at the left contains metals of the rare earths. The large rectangle contains most of the heavier metals which are of metallurgical importance. Bordering on this are the light metal, aluminum, and the semi-metals, antimony and bismuth. The elements enclosed in the triangle are usually regarded as non-metallic.

Thus it is evident that the general chemical properties of an element can be foretold, if its position in the periodic table is known.

Enough experimental work has been done to point to a similar relation and gradation for the physical properties of the elements. This is shown quite clearly in the case of the melting points, which have been included, for comparison, with each element in the above periodical table. It will be seen that almost without exception, these range quite regularly from low to high, or from high to low, in any given column, and in reading through any horizontal group it will be noted that successive figures do not represent very great contrasts. This same general relationship governs the other physical properties of the metals. Take, for instance, malleability or ductil-

ity; these will increase or decrease from the upper to the lower quite regularly. Column Ia is a good example of this. Copper is very easily drawn or otherwise manipulated; silver, the next in the same column, is much more malleable and ductile; while gold, at the bottom, is the most malleable of known metals.

Hence, if a certain metal possesses special properties which make it valuable for industrial purposes, it is reasonable to suppose that those metals which occupy adjacent positions on the periodic table, may possess this same property to some extent at least, and would, therefore, bear investigation, especially if it came within the same vertical column.

These same general laws must be recognized when the alloying properties of the metals are under consideration.

ALLOYS

When two metallic substances are brought together in the liquid state, or melted together, the conditions possible are very similar to those found when two ordinary liquids are mixed. As when water and alcohol are poured into the same receptacle a complete solution of one in the other takes place. Alloys of gold and silver are good examples of this. Or, they may act like oil and water, separating into two distinct layers, with the heavier substance on the bottom. Thus it is impossible to form alloys of iron and silver. This condition is, however, not so commonly met with, as most metals will disolve varying amounts of another. A condition frequently met with is one similar to that which is encountered when ordinary salt is dissolved, to saturation, in water. In the liquid state there will be uniform homogeneous mass. When the temperature is lowered, however, salt or water will crystalize out until the saturation point at the freezing temperature is reached, when both freeze as a conglomerate of the separate crystals, each practically free from the other.

This point is known as the eutectic, and in this case, as in that of metallic alloys, the freezing point is lower than that of either component or of any alloy of the series of different composition. Thus the lowest possible temperature is reached with ice and salt or water and salt, when they are present in eutestic proportions, i. e., about 20% of salt to 76% water, which freezes at -23.0 degrees C. (about 9.0 degrees below zero F.) The silver-copper series is a good example of this.

Then again, the two substances may have a chemical affinity for each other, and when melted together, form definite compounds. This is usually the case when the metallic elements are brought in contact with those which are much less metallic. There is still another condition, one involving two or more of the above in the same alloy. Two metals may be mutually soluble to a limited extent, and may form compounds at the same time, which also may be soluble in the excess material. Also it is common for two components to form a small amount of eutectic which collects between the crystals of the excess metal.

By comparing the properties of different alloys containing different constituents, it has been proven that certain constituents impart certain characteristic properties to the alloys of which they form a part. In fact, the relation between the constituents of an alloy and its industrial application may be predicted for certain alloys, if its constituents are definitely known. Conversely if a certain application is desired, a definite limit may be placed upon the number and amount of constituents permissible.

Fortunately, the number of constituents which may be present in an alloy is limited to the four as outlined above: (1) pure metals, (2) solid solutions, (3) compounds, and (4) eutectics. Without going into a detailed theoretical review

of these, a short summary of their imparted characteristic properties will show clearly the value of any information regarding their presence. A great number of binary alloys of the more common metals have been studied by melting together those of one series in different proportions, and noting all critical points by means of an accurate and sensitive thermo-couple and galvanometer. When all related points are joined, the resulting diagram, giving percentages on a horizontal line and temperatures vertically, is divided up into areas showing definitely the range of certain constituents as defined by their critical points. These constituents are verified by microscopical examination and by chemical analysis. Therefore, knowing the properties of the constituents, it is possible to predict, to a certain extent, the mechanical properties of a binary alloy of any composition, by observing on the equilibrium diagram, just what constituents are present at the given composition. As stated above, the number of these constituents is limited to four, which will now be taken up in order, giving their characteristics as far as known.

(1) **Pure Metals** are present in an alloy of which the components possess only limited solubility or which form eutectics or compounds to a limited extent only and which are insoluble in the metal. It is evident that they tend to impart their own properties to the alloy, when this is not counteracted by the character of the matrix.

(2) **Solid Solutions.** In these, each individual crystal is made up of molecules of the different components. These may replace each other by varying amounts. and the presence of even a few molecules of one metal arranged among the molecules composing a crystal of another metal may cause a profound change in that metal. However, solid solutions possess similar properties to those of the elements of which they are composed. If the elements possess these properties, the solid solutions of these will also be soft, malleable, or ductile, etc. It may be pointed out that all industrial alloys which are capable of being cold rolled, drawn, or otherwise worked, consist of a single solid solution. Brass, bronze containing less than 8% of tin, coinage bronze, aluminum bronze containing less than 7.5% of Al., copro-manganese, cupro-nickel, German silver, standard gold, Magnalium, and some of the nickel and steels are examples of ductile alloys consisting of a single solid solution. Standard silver may be regarded as an exception to the rule, but the quantity of eutectic here present is very small; also, the silver-copper eutectic is exceptionally ductile when compared to other eutectics. Alloys of two solid solutions are usually less ductile, but are still capable of being rolled and worked while hot. Muntz Metal, manganese-bronze, delta metal, and a number of special bronzes and brasses examples of this latter type.

(3) **Compounds** are harder, usually, than the metals of which they are composed, and nearly always brittle. They decrease the ductility of an alloy and tend, usually, to lower its tensile strength. On the other hand, the presence of compounds may increase the compressive strength of the alloy, a property which is of great value in certain cases. The industrial alloys of this class include bronzes containing more than 8% of tin, cast phosphor bronze, all the white metals, anti-friction alloys, and the aluminum alloys containing copper, nickel or tin.

(4) **Eutectics** are usually quite brittle and possess lower melting points than either of their components. Eutectics of more than two metals have a lower melting point than those of only two, and advantage is taken of this fact in making the various fusion alloys, for safely plugs, etc. Owing to the fact that eutectics melt at a low temperature, this part will be the last to solidify, and so will

form between the crystals of the other constituents, forming a network, or cement, with the result that the strength and ductility of the alloy are practically the same as that of the eutectic portion.

It follows, then, that alloys containing eutectics are, with one or two exceptions, unsuited for constructional work. Their principal employment is probably in the form of solders, in which the difference in melting point of the constituents enables them to be manipulated in a semi-fluid, or pasty condition. The eutectic, or eutectoid, of carbon and iron, known as pearlite, is an exception to this rule, and is unique in that it forms after the steel is completely solid. The result of this is that the crystals of iron are not surrounded by eutectic, but the eutectic itself is surrounded by free iron, so that the formation of pearlite in steels is rather more comparable, as regards its influence on the mechanical properties, with the formation of compounds in other alloys. Alloys containing eutectics are sometimes rendered useful by chilling, so that the eutectic is not permitted to solidify between the crystals, but is evenly distributed throughout the mass.

Theoretically, when alloys containing more than two constituents are considered, the subject becomes much more complex. From a practical point of view, however, the difficulties are not greatly increased, for these alloys contain as before, metals, solid solutions, compounds, and eutectics. A solid solution of three metals may differ in hardness, strength, or ductility, from a solution of only two, and it is true that a eutectic of three or four metals has a lower melting point than one of only two, but the general characteristics of the constituents are the same. Solid solutions are the ductile constituents; compounds are the hard and brittle constituents; eutectics are usually rather hard and brittle, and tend to solidify between the grains of the alloy, thus destroying its ductility.

From this it would seem that present research should be confined pretty closely to those alloys made up of solid solutions only, or to those containing at least only a very small amount of compound or eutectic. Especially is this true where malleability, tensile strength, and ductility are required.

There seems to be no general law applicable to the expansion of alloys with change of temperature. In general, when heat is applied to a body, it expands, and the proportionate increase in length, per degree centegrade, is known as the coefficient of expansion. That for platinum is .0000089, for tungsten it is .0000040, and for molybdenum it is only .0000036. For the other it ranges upward from about .000014.

Most of the available data on this subject is with reference to the nickel-iron alloys and the nickel steels.* In the nickel-iron alloys, those of about 37% Ni. have a coefficient of expansion, for ordinary temperatures, of practically zero. The explanation** given for this is briefly as follows: Iron may exist in one of three molecular modifications, depending upon the temperature.—(1) Alpha, magnetic; (2) Beta, non-magnetic; and (3) Gamma, also non-magnetic. Alpha iron is that form which is common at ordinary temperatures. This undergoes a molecular change at 780.° C., forming Beta iron, which in turn changes into Gamma iron at 880.° C. Now the presence of about 37.% of nickel has such an influence upon the molecules of iron that they are unable to change their state when cooling from the gamma state (above 880.° C.), and so remain stable as crystals of Gamma iron. As this Gamma iron has already undergone its normal expansion throughout the Alpha and Beta range, and does not lose this again on cooling (because this reversion is not permitted to take place again on

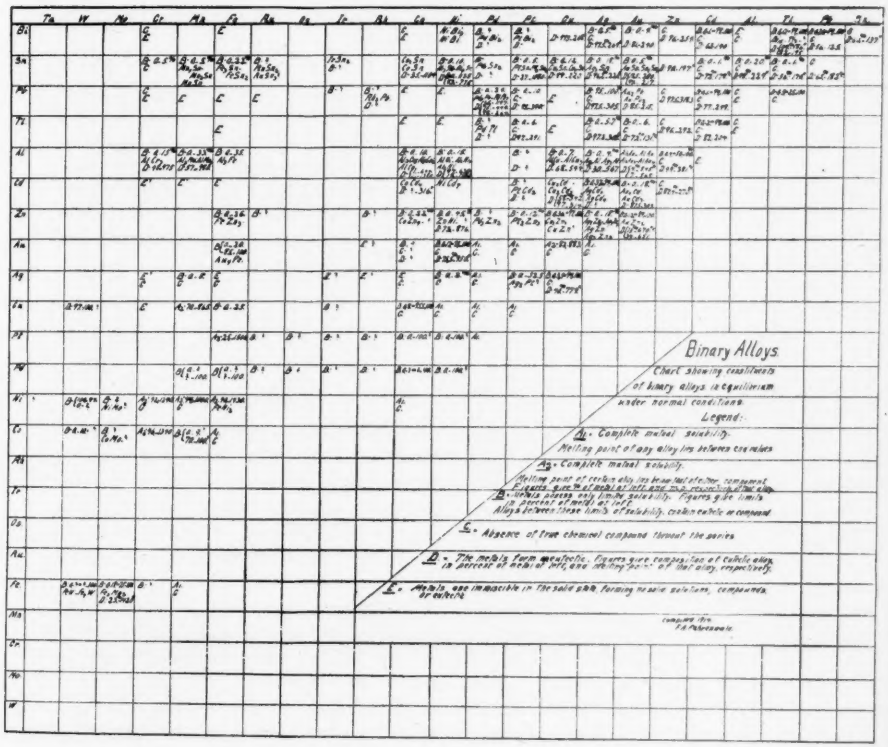
*Charpy and Grenet—Metallographist—6, 328.

**C. E. Guillaume, Non-expansive Alloys-Metallographist, 6,162.

cooling), it is natural that there should be no expansion upon reapplication of heat, until the normal Gamma temperature is again reached.

In this series the change in coefficient of expansion is due to the presence of a

Figure 3


Binary Alloys.
Chart showing constituents of binary alloys in equilibrium under normal conditions.
Legend:
A1 - Complete mutual solubility.
Melting point of any alloy lies between the values
A2 - Complete mutual solubility.
Melting point of any alloy lies above that of the component
B - Metals possess only limited solubility. Figures give limits
Alloys between these limits of solubility, crystallizable as
C - Absence of true chemical compound through the series
D - The metals form eutectic. Figures give composition of eutectic alloy,
E - Metals are immiscible in the solid state, forming mosaic solutions, compounds
compare this
Ti Patterson

transformation point, i. e., a change from one allotropic state to another—but this does not necessarily mean that the coefficient of expansion cannot be modified in alloys formed of metals having no transformation points. However, sufficient data is not available from which to formulate governing rules.

The above discussion has in a very general manner outlined the relationship of the elements when arranged in the periodic order of their properties; it has pointed out the similarity of elements in each vertical column, natural families they may be called; and has shown that there is no radical difference in the properties of succeeding elements of a horizontal row. The general properties of an alloy have been shown to depend upon the constituents of that alloy, and, in turn, these constituents have been briefly discussed with reference to their characteristic physical properties, and with reference to the probability of the occurrence of similar constituents in alloys of closely related metals. In many cases

not enough experimental work has been done to define their metallurgical relation, but from their relative position in the periodic table, this relationship may, to a large extent, be assumed. Thus, in column 6 (Fig. 1) the alloying properties of chromium have been fairly well worked out, while regarding those of molybdenum and tungsten very little is known. However, judging from their relative positions in the table, it may be reasonably supposed that a metal which forms a solid solution with chromium, will, with molybdenum, and perhaps tungsten, with certain properties greatly intensified or reduced. Nevertheless it is not safe to generalize in too broad a manner upon any assumed relationship between certain alloys which have not as yet been tried out; but it would be impossible to make an intelligent search for an alloy possessing certain specific properties, without having definitely outlined the properties of the different elements and their relationship and behavior toward each other.

Fig. 2 is a table of all the elements with which this work will probably have to do, arranged in systematic order, showing so far as has been worked out, the types and amount of constituents formed when any two of them are alloyed or melted together in any proportion. The blank spaces represent combinations which have not been investigated in systematic manner, or regarding which nothing definite is known. However, knowing the general relationship between the different groups these may be tentatively filled for purposes of comparison.

In attacking this problem the plan has been adopted of investigating all feasible combinations of one promising metal at a time. This metal will serve as a foundation to which such other elements, as would promise a proper modification of its properties, are added. It is obviously advisable to choose as such, a metal which lies in or adjacent to the squares containing the precious metals, or to use such of these as is least costly. The most promising are silver, palladium, and nickel, all having rather high melting points, and being very resistant to corrosive influences. Nothing quite satisfactory being found in one of these, in their various combinations with other elements, the work has been continued with tungsten, molybdenum, platinum, iridium, etc.

In accordance with this plan the alloys of silver will be taken up, giving first the equilibrium diagram, showing the constituent at any percentage composition, and at any temperature up to and above the melting point of the more infusible metal. This diagram will at once reveal the possibilities, which will be discussed briefly, followed by experimental results available.

Before the alloys are taken up a brief word as to methods and apparatus is thought advisable.

APPARATUS.

The metals used in making up all alloys were the purest obtainable, and before alloying were checked by careful chemical analysis in order to guard against impurities which might affect results. For the chemical analysis of the elements used, this laboratory is fairly well equipped, as it is for all melting operations, but for the more special work of the future, some special apparatus should be supplied.

The furnace used in melting the various alloys is that known as the "Gran-Annular Electric Furnace" and was presented for use, while in the present location, with the compliments of the inventor, Dr. Chas. H. Fulton, who is Dean of the School of Mining Engineering at Case. In this furnace, temperatures are available up to 2000.° C. (3600.00° F.) The atmosphere generated within this furnace consists of CO* and N. with a small fraction of one per cent of 0. This reducing atmosphere is ideal in all cases

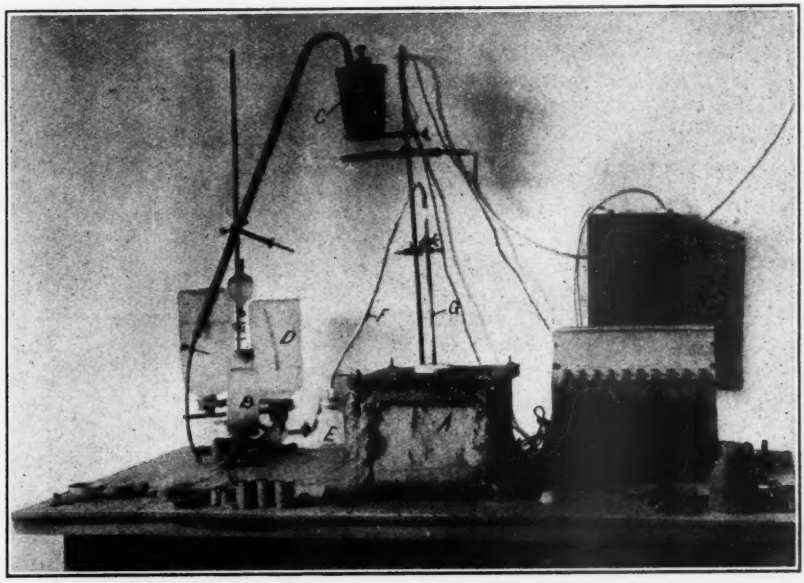
where the presence of CO is not objectionable. For use in melting the alloys of iron, nickel, palladium, platinum, etc., where C may not be present; an atmosphere of N or H may be used very easily.

Fig. 4 shows the set-up of furnace and connections. A. is the furnace; B. is the hydrogen generator; C. the nitrogen generator; D. pressure bottle for storing and maintaining pressure on gas. The gas

For microscopical work there was placed at our disposal the complete metallographic equipment of the metallurgical department of the Case School. This consists of all necessary grinding and polishing apparatus, and a microscopical set-up which is not excelled in this country.

As special precautions must be made at all times to prevent the introduction

Figure 4



to be used as an inert atmos. is conducted from bottle D. through wash bottle E.; then through rubber tube F. to quartz tube G., which leads directly into the interior of the furnace.

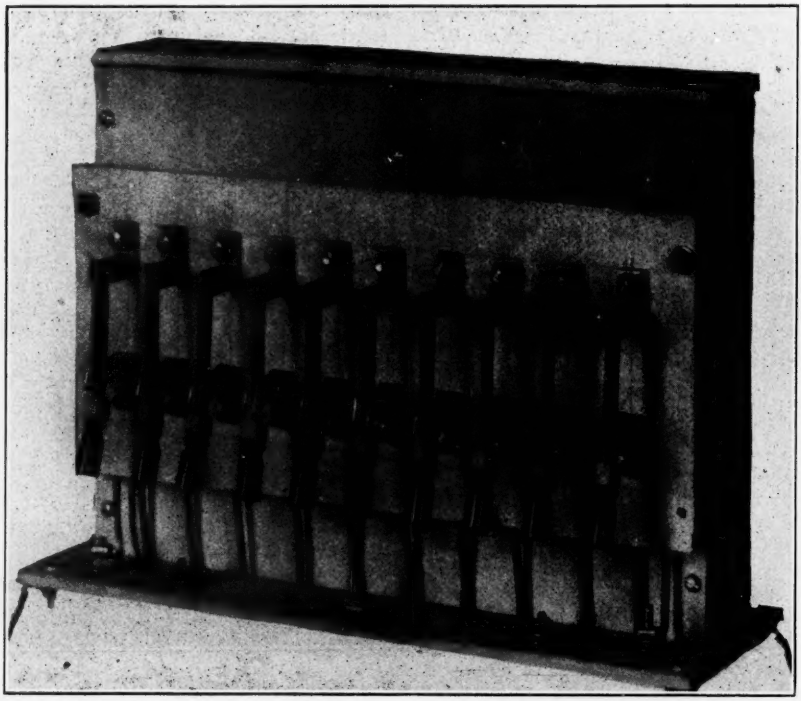
A current (D. C. or A. C.) of 20 to 35 amps. is necessary and to control this, a resistance box costing about $60 would be necessary. To avoid the burden of this additional expense to the commission, the control shown in Fig. 5 was designed. The cost was thereby very small.

of impurities, it was sometimes found necessary to make crucibles of special materials. Small amounts of carbon, silicon, etc., are very detrimental in some alloys, e. g. the nickel and palladium alloys. Alundum crucibles are splendid for many purposes, but, although there appears no record of a similar reaction, it was found that the Al_2O_3 was slightly reduced in several cases; as is testified by the fact that small amounts of Al. were found, and gave trouble in several alloys of nickel, which re-

quired a high temperature and a reducing atmosphere. Fig. 6 shows a special form of mould which was devised for use in making crucibles of magnesia, etc. In making these it was found necessary to first compress the Mg. O., then ignite at a very high temperature. This material was then reground and incorporated with a small amount of a suitable binder and again subjected to a very high pressure. In order to prevent the material from adhering to the surface of the mould, it was necessary to line the outer cylinder with a removable sheet steel jacket, which in turn was lined with a heavy greased brown paper. The piston was also coated with a heavy grease.

Table Fig. 7, 8, 9 and 10 give a list of the elements, together with the crucible material and atmosphere in which each may be melted. This gives the recommendations of the most advanced workers along this line.

Figure 5



ALLOYS OF SILVER.

Silver-Aluminum* 1. Fig. 11, shows at once the limitations of this series. The melting point of any alloy of the series lies below that of silver, so that unless the addition of a third or fourth

*1. Heycock & Neville, Phil, Trans. 189. A., p. 25.

Heycock & Neville, J. Chem. Soc. 73, 714.

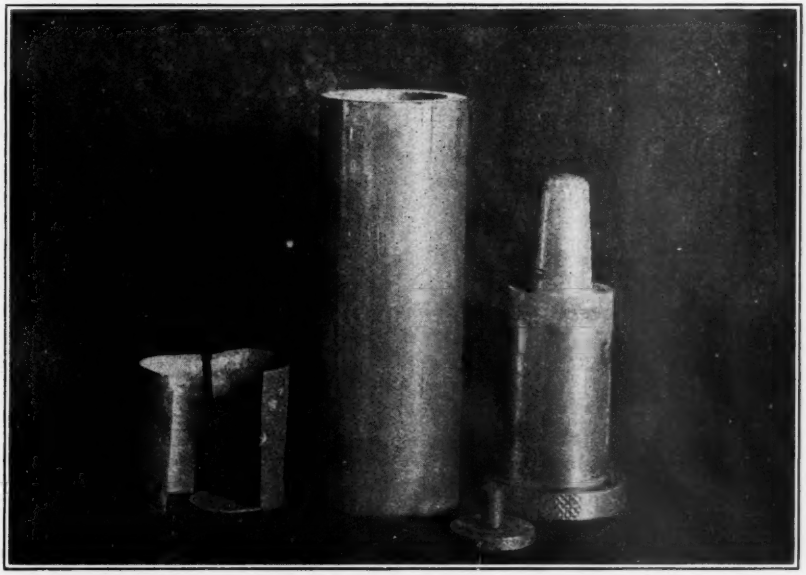
2. Petrenko, Zeit. Aborg, Chemie. (1906) p. 133.

element would bring the m. p. up to amount 1200.° C. these alloys are not suited to hi-temp. work. Record of several Ag-Al alloys appears in the current literature, but their value has not been proved to such extent as to warrant their adoption in structural work.

tion. For standard, factory made parts, they might be of value.

In order to test the possibilities of those of high silver content, alloys of .5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0 per cent, respectively of Al. were made up. It was found that the alloys

Figure 6



Certain alloys of this class which are made up of about 95% Al., 3% Ag., 2% Cu. are used in the manufacture of beams and balances, and in various scientific instruments, in which light weight is of some advantage. The above composition, however, varies considerably. It is not likely that the high Al. alloys will be of much value in dental practice, on account of their difficult manipula-

containing over 1.0% of Al. were much less malleable and ductile than pure silver, and quite brittle, while those of under 1.0% were very similar to pure silver. This was to be expected, as the addition of even a small amount of Al forms a chemical compound, which, when dissolved in the excess silver, decreases the ductility and malleability to a marked extent.

Figure 7

Metal.	Crucible Material	Protective Cover	Inert Atmosphere
Na.	Porcelain, coated with oil and graphite. Jena glass, up to 750°C. Iron - wrought or cast preferrably.	Vaseline with benzine or paraffin Petroleum.	H_2, altho the hydride is formed.
K	Porcelain, is not trustable Jena glass - altho a black coating is formed. Iron - wrought or cast may be used, altho Ni - K, alloys are formed.	As above - but with vaseline and paraffin the molten globules are not together with difficulty. Petroleum is especially good	As above.
Li, Rb. Cs.	Similar to K. Jena glass is strongly attacked by Li.	As above	As above
Ca	Porcelain - not recommended. Iron - satisfactory below its melting temperature.		CO_2, N_2, H_2 have not given satisfactory Vacuum is recommended
Ba, Sr.	As for Ca		As for Ca.
Mg	Graphite, is good, but with slight reaction, better fused with magnesia Porcelain should not be used - better glass, at low temperatures. Magnesia crucibles are too porous	NaCl + KCl, good for Mg alloys. Pure Mg. fluxed on the above fusion as it is better to use a mixture of KCl + LiCl.	CO_2 cannot give good results. H_2 should be used

Figure 8

Metal	Crucible Material	Protective Cover	Inert Atmosphere
Al.	Porcelain - may be used for certain alloys. Jena glass - may be used for quick fusions. Alundum is good but very porous. Fire Clay.	KCl + Na Cl - altho some salt may be retained. NaCl Better fused without cover.	H_2 and N_2 are recommended. Oxygen must be eliminated, or boron cannot be melted together
Rare Earth Metals	As for Al.	As for Al	As for Al.
B.	Graphite, Porcelain, or earthy material not recommended. Boron crucible must be used	B_2O_3	H_2
C	Charcoal or Graphite	$2BaCl_2$ + KCl	H_2 or N_2
Si	Graphite, or magnesia lined crucibles may be used for quick fusion		H_2 or N_2
Ti, V.	Similar to above		As above.
U, W. Mo, Cr.	Carbonaceous material not permissable Magnesia lining may be used Magnesia or alundum may be used if not surrounded by gaseous hydrocarbons or by CO_2 or CO.		H_2 or N_2

Figure 9

Metal.	Crucible Material	Protective Cover	Inert Atmosphere
Mn	Magnesia - or a lining of magnesia is recommended. Porcelain is rather strongly attacked. - The presence of silica or carbon is to be avoided. Alundum should find application here.	Charcoal must not be used $BaCl_2$ may be used	H_2 N_2 CO_2 - must not be present.
Fe.	Porcelain is recommended. Magnesia Graphite - with Mg lining. Carbon or oxides should not be in contact with fusion Alundum - is good, but very porous	$BaCl_2$ KCN will cause ige. - $MnNH_4 + MnO_2$ - Gypsum Charcoal powder is not permissable	H_2 N_2 - forms the nitride CO or CO_2 will cause ige iron
Co.	As far iron except that porcelain is strongly attacked by the oxide formed	As for iron	H_2 N_2
Ni.	As above - Small amts of Al have been found in Ni melted in an Alundum crucible in reducing atmos. -	As above	H_2 N_2
Ru. Rh. Pd. Os. Ir, Pt.	Carbonaceous materials had best be avoided. Magnesia Alundum.	Glass	H_2 forms alloy with Pt.

Figure 10

Metal	Crucible Material	Protective Cover	Inert Atmosphere
Cu.	Charcoal, Graphite Porcelain, Fire Clay Magnesia - Silica Alundum.	KCl + NaCl B_2O_3 - Borax. KCN Charcoal	H_2, N_2, CO, CO_2, Illuminating gas free from Sulphur.
Ag.	Nickel, Iron, Fire Clay Graphite, Porcelain. Alundum	KCl + Na Cl KCN, Borax.	H_2, N_2, CO_2 Illuminating gas.
Au.	Practically any non-metallic crucible.	As for silver not necessary.	
Zn.	Jena glass Graphite	KCl + Na Cl. $NaNO_3$ + MnO_2. Gypsum Charcoal powder	H_2 Illuminating gas.
Cd, Hg, In, Tl.	Jena glass. Graphite, Porcelain.	KCl + NaCl or LiCl. Vaseline oil with benzine Charcoal powder.	H_2 N_2 CO_2, CO.
Pb, Bi, Sn, Sb.	Graphite. Charcoal.	Borax, Glass, KCl + NaCl or LiCl. KCN. Charcoal.	H_2 N_2 CO_2, CO
As, P.	Magnesite - Silica	$BaCl_2$, B_2O_3 Borax reacts KCN, Charcoal.	N_2; CO_2; CO. H_2 reacts at high temp.
Te, Se.	As above	Borax does not react, as above	H_2; N_2; CO_2; CO.
S.	As for As. and P.	As for As. + P.	As above

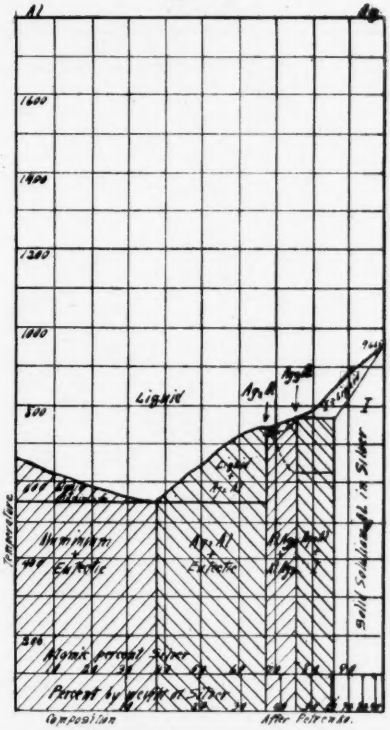
Silver-Bismuth* 1. Fig. 12.

The nature of these alloys are very clearly shown by the diagram. Silver dissolves bismuth to the extent of about 4. -5. %. Larger amounts of bismuth go to form an eutectic with this saturated mixed crystal. (That is, the crystals are made up of a homogeneon mixture of molecules of Ag and Bi). While this series might give something of use for amalgams for filling purposes, it does not offer any points of interest in connection with the post and pin problem. These alloys are especially susceptible to the influences of sulphur compounds.

Silver-Cadmium* 3. Fig. 13.

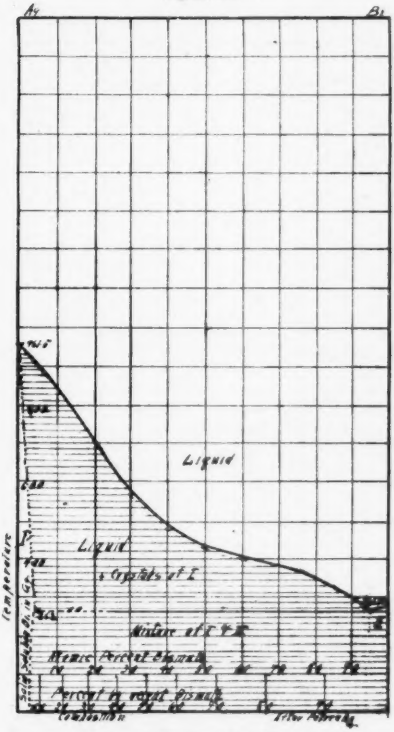
Cadmium, silver, and tin are ingredients of some soldering compounds, and certain amalgams. Silver alloys containing up to 30.0 % Cd. are very malleable, although not quite so tough as pure silver, and should furnish alloys which may be suitable for cast filling purposes. As shown in the diagram, a low m. p. is characteristic of these alloys. They

Figure 11



Silver-Aluminum Series.

Figure 12



Silver-Bismuth Series.

*1. Heycock & Neville, Ternare verbindungen, J. C. S. 65, 65.
Heycock & Neville, J. Chem. Soc., 62, 888.
Heycock & Neville, Chem. News, 62, 280.

2. Petrenko, Zeit. Anorg. Chemie, (1906) p. 136.

3. Kirk-Rose, Proc. Royal Soc. 74, 218.

would, no doubt be quite susceptible to sulphiding influences.

Silver-Chromium. Fig. 14.

Although silver and chromium seem to be very slightly miscible in the molten state, they crystalize out in two distinct layers of the pure metals, and as silver will not dissolve chromium in the solid state, there is small chance of raising its m. p., or of changing its physical properties in any way by the addition of chromium in the binary form.

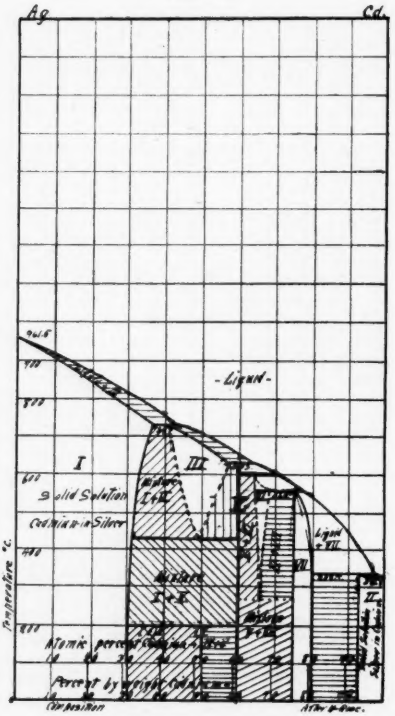
Silver-Cobalt. Fig. 15.

These metals are immiscible in both the liquid and solid states, and offer no alloys which as a binary, would be of any value.

Silver-Copper* 1. Fig. 16.

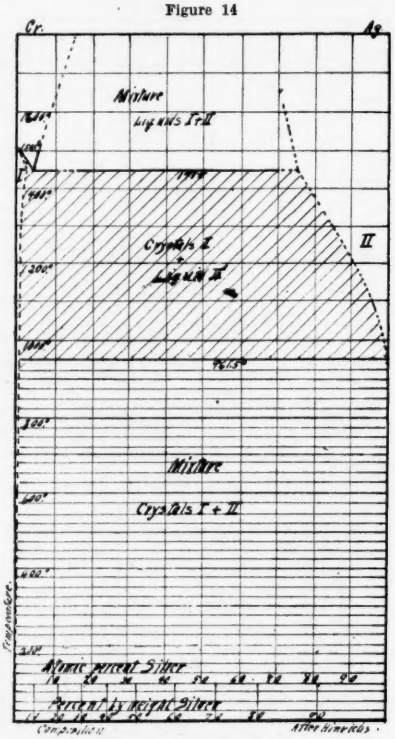
Silver will dissolve up to about 6% of copper, retaining this amount as a solid solution. A perfectly homogeneous alloy of this composition is only obtained by maintaining the material at a temperature near its melting point for a number of hours. Small amounts of copper harden silver quite appreciably, making it

Figure 13



Silver-Cadmium Series.

Figure 14



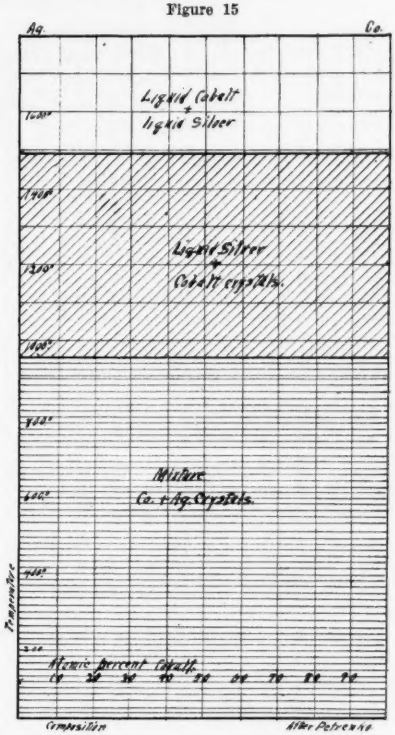
Silver-Chromium Series.

*1. Heycock & Neville, Phil. Trans., (1897) p. 786.
Lepkowski, Z. Anorg. Chemie, 59, 285.
Friedrich & Leroux, Metallurgie, 4, 297, (1907).

more resistant to mechanical abrasion. This fact is taken advantage of in the manufacture of coins, etc.

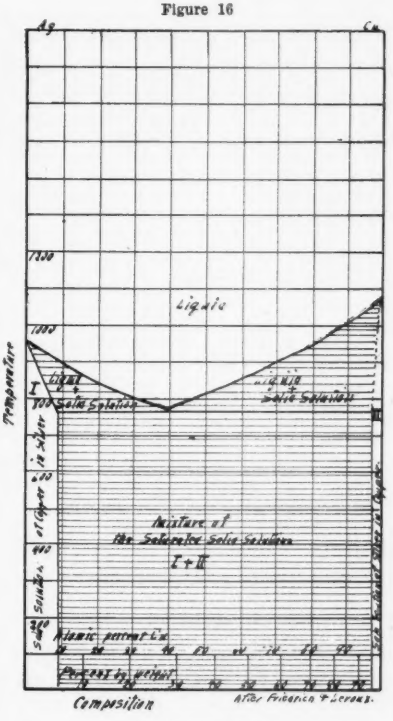
The eutectic alloy melts at 778.° C. and is quite hard and brittle.

Figure 15



Silver-Cobalt Series.

Figure 16



Silver-Copper Series.

Silver-Gold* 1. Fig. 17.

The diagram shows a complete series of solid solutions. These are slightly harder than their components and have silver. During this range the drop is not over 12.0 degrees C. below the melting point of pure gold. On the other hand, the addition of a small amount of gold raises the melting point of silver considerably.

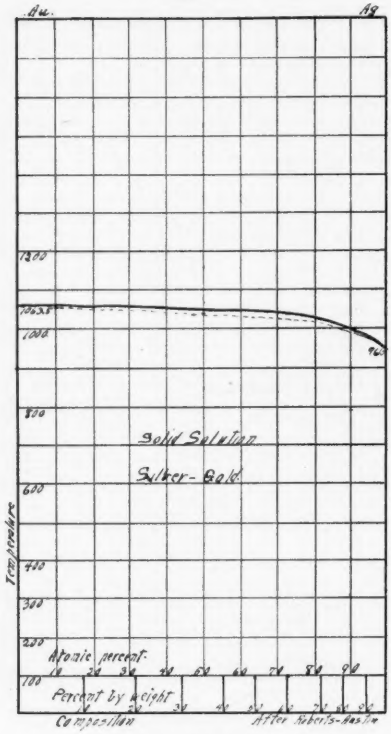
The melting point of any alloy of this series may be raised to a very high degree by adding platinum or palladium, without destroying certain desirable properties, as will be shown later. The addition of even a small amount of base

*1. W. Campbell, Jour, Franklin Inst. (1902) pp. 131, 201.
C. Hatchett, Phil, Trans. (1903) pp. 43-93.
Hershkowski, Zeit. Phys. Chem., 27, pp. 123, 894.
Heycock & Neville, Phil. Trans. 189 A. 225 (1897).
Roberts-Austin & Kirk-Rose, Proc. Roy. Soc. 71,161.
Roberts-Austin & Kirk-Rose Chem. News, 1, 151.

2. Roberts-Austin, Phil. Trans., 187 A., J. B. p. 23, (1896).

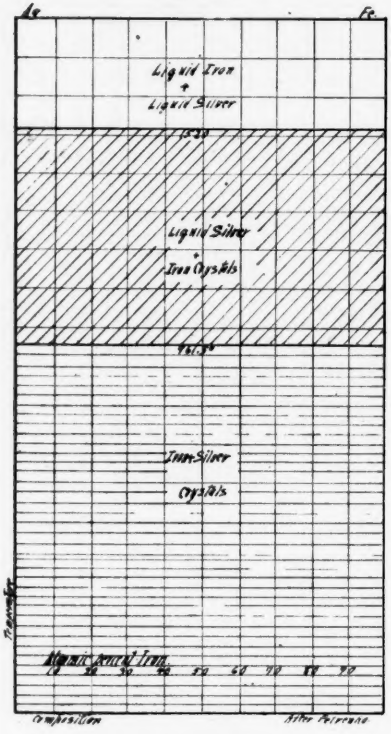
metal causes these alloys to be very susceptible to oxidation at high temperatures. The addition of such metals as nickel or cobalt produces a coarsely crystalline material which does not promise much. Those alloys of over about 30.% Au. are not easily darkened by sulphide compounds.

Figure 17



Silver-Gold Series.

Figure 18



Silver-Iron Series.

Silver-Iron. Fig. 18.

Silver and iron have not been found to alloy under ordinary conditions, at any temperature.

Silver-Lead* 1. Fig. 19.

This series offers nothing of interest in the present problem.

Silver-Manganese. Fig. 20.

Manganese dissolves a small amount of silver in the molten state, which lowers its melting point by about 6.0° C. Upon solidifying they crystalize as a conglomerate of pure silver crystals and crystals of II.

---

*1. Heycock & Neville, Phil. Trans. 189-A. p. 3. (1897).
Friedrich, Metallurgie, 3, 396.

Silver-Magnesium* 2. Fig. 21.

Promise of entirely negative results have been predicted for these alloys from a structural point of view.

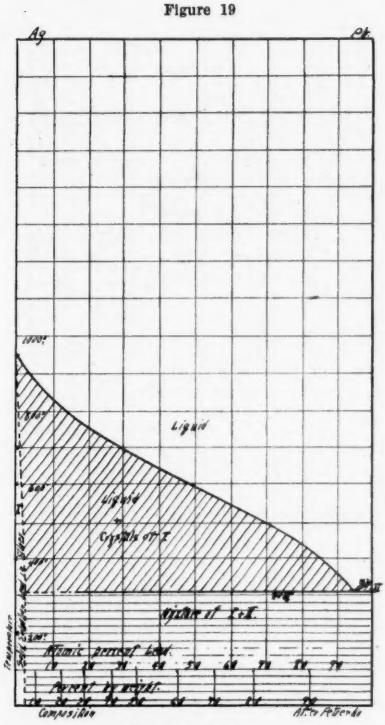
Silver-Nickel* 3. Fig. 22.

These are practically immiscible in the solid state; nickel retaining about 2.0% of silver in the solid state. This small amount does not seem to enoble the baser material to any extent. As a binary, these alloys promise very little.

Silver-Palladium* 4. Fig. 23.

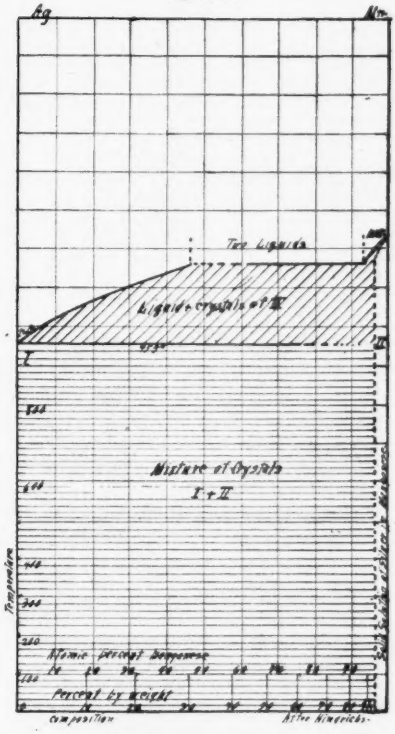
According to the equilibrium diagram, silver-gold series. As is shown on the freezing point curve the alloy having 70.% Ag. and 30.% Pd. melts at about 1200.° C. These alloys are said to be very hard, and to take a very high polish. However, the specimens made up in this laboratory showed physical properties ranging between those of silver and palladium, especially with respect to the hardness. The alloys of over 20.% Pd. have one characteristic feature which might be made use of. These alloys showed no coloration when immersed for several days in the same sulphide solution which blackened pure silver very rapidly. An alloy of this type could be made at about $5.00 per c. c. as com-

Figure 19



Silver-Lead Series.

Figure 20

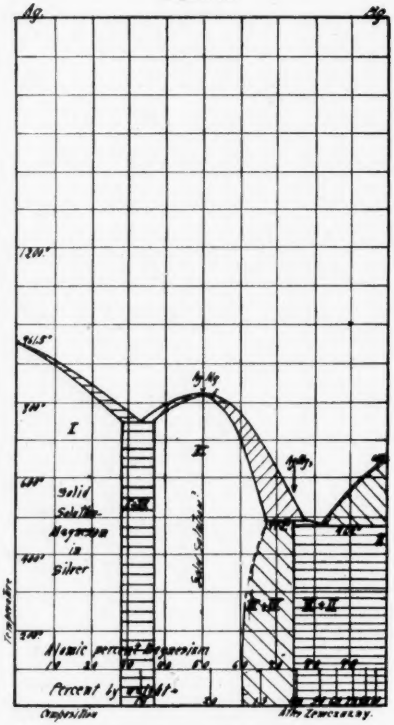


Silver-Manganese Series.

2. Zemczuzny, z. An. Ch., 49, 400. Parkinson, J. Am. Ch. Soc. 20, 17.
3. Petrenko, Z. An. Ch. 53, 212. (1907). Petrenko, Z. An. Ch. 53, 200.
4. Ruer, Zeit. Anorg. Chemie. 51, 315.

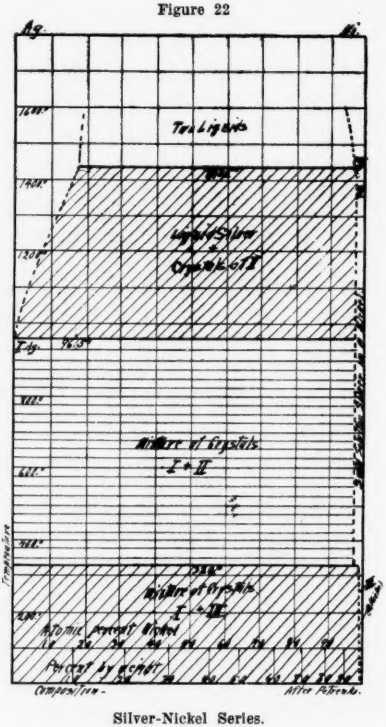
pared to $12.50 for gold. This series might also serve as a basis for ternary alloys, as palladium is one of the best solvents for a great many metals, including nickel, iron, cobalt, tungsten, molybdenum, etc. These will be taken up after the binary alloys of silver have all been considered. It is possible that the addition of small amounts of another metal will impart the necessary hardness, even though it would not alloy in any proportions with silver alone.

Figure 21



Silver Magnesium Series.

Figure 22



Silver-Nickel Series.

Alloys ranging from 1.% to 95.% Pd. were made up in this laboratory, and all showed very valuable properties. All samples were so soft and malleable as to permit of being rolled into very thin foil. In this operation, however, precautions must be taken to anneal frequently during the first stages of the rolling, as the ingot material shows a tendency to fracture quite readily. After the material has been reduced to sheet form this tendency seems to have been overcome, and the material may easily be reduced to thinest foil.

This foil is apparently as soft as Pt. foil and as the m. p. can be varied between 961. and 1551. ° C. it should serve as a very acceptable substitute. Tests made showed it to be unaffected by saliva solution, or by a sulphide solution. It is insoluble in HCl; very slightly soluble in H_2SO_4, and practically insoluble

in Aqua Regia. It is soluble only with difficulty in HNO_3.

This alloy will also solder very readily onto any of the metals or alloys used in dentistry. Therefore, these silver-palladium alloys should form a practical substitute for the pure platinum foil, which often costs from $30. to $50. per cc., while this material could be made for from $5 to $15 per cc., depending upon the grade of alloy. These alloys will be summarized at the end of this chapter.

Figure 23

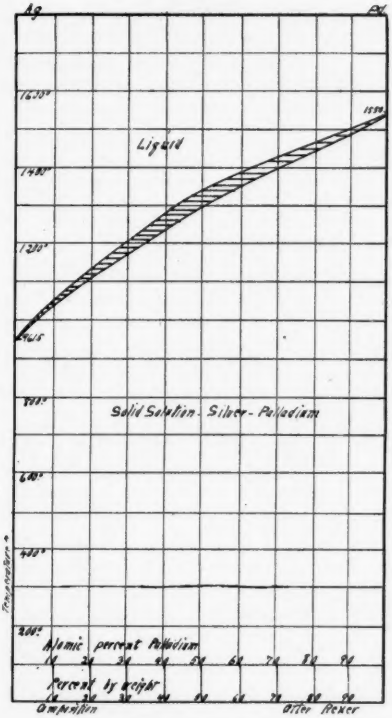
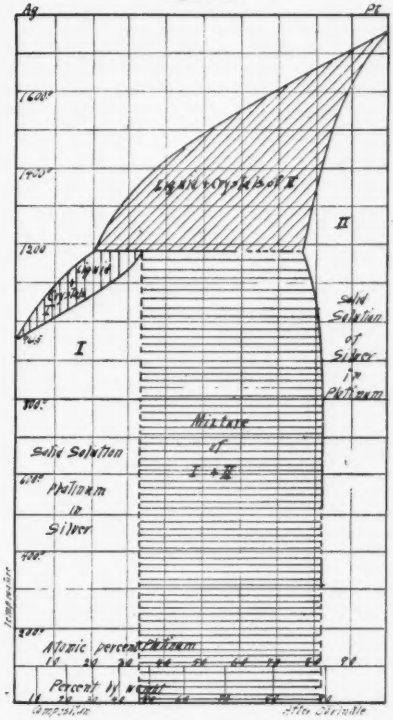


Figure 24



Silver-Platinum* 1. Fig. 24.

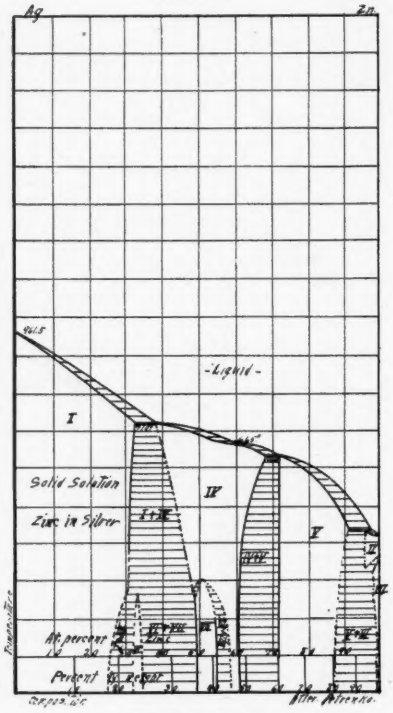
The diagram for the Ag. Pt. alloys shows two series of solid solutions, to which may be confined any alloy of industrial importance. Of these, series I should be of special interest. Series II alloys are of over 90.% Pt. content and so are too costly to permit of consideration. The alloys between 47.5% and 88.0% of platinum are probably made up of a mixture of crystals I and II (crystals I, silver saturated with platinum, and II platinum saturated with silver). Those alloys lying near the saturation point of I should possess the most marked properties, as to hardness, etc., while those between I and II should be, and are, very brittle.

To determine the applicability of these

*1. Miller, J. Am. Ch. Soc. 28, 1115.
2. Doerinkle, Z. An. Ch. 54, 338.

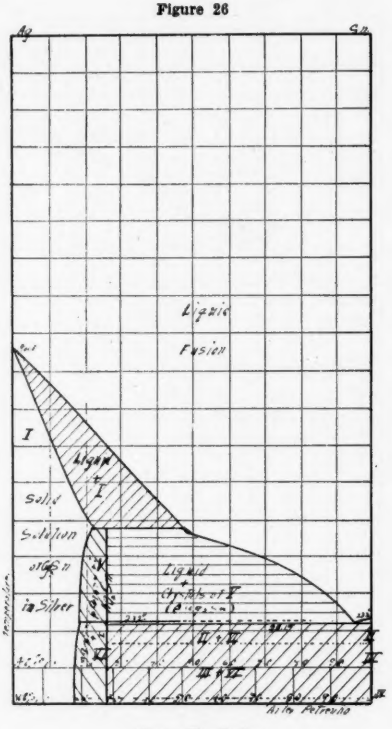
alloys to the problem in hand, a series of alloys were made up, varying by 5.% of Pt. The addition of small amounts of Pt. to silver increases the hardness considerably, and at 10.% could still be drawn although the resulting wire did not possess great strength. Above this

Figure 25



Silver-Zinc Series.

Figure 26



Silver-Tin Series.

Pt. content further addition seems to increase the hardness at the expense of tensile strength and workability. The Ag.-Pt. alloys are also quite resistant to action of sulphides, especially when the material has been quenched in dil. HNO_3, which dissolves the silver from the surface. Alloys of about 25. -30.% of Pt. are practically insoluble in any acid, or in Aqua Regia. In the case of acids the material is protected by the Pt., and where Aqua Regina is used the insoluble coating of AgCl., prevents further action. However, as a substitute for the Pt. Ir. alloys this series does not offer much. While the addition of Pt. to silver causes the m. p. to rise practically as much as does the addition of an equal amount of Pd., the hardness imparted would make the alloy worthless as a foil material, in which malleability and softness are necessary. The material of sufficiently high m. p. is too brittle for posts and pins. These alloys are in no way equal to the silver-palladium alloys. The

binary alloys of silver with zinc and with tin are shown in Figs. 25 and 26.

Silver-Tungsten. Silver-Molybdenum.

No reference has been found relative to these alloys but from experiments made in this laboratory, they appear to follow the group tendencies as shown by the Ag-Cr. series. These fusions must be made in an atmos. of H. or N, as the presence of small amounts of O seems to tend toward the formation of tungstate or molybdate of silver, which apparently is dissolved in the silver. Microscopical analysis of specimens which were made in an atmos. of nitrogen, showed the unalloyed particles of tungsten or molybdenum, imbedded in the silver matrix.

SILVER ALLOYS—SUMMARY.

Neither the time or the necessary apparatus were available with which to carry out exhaustive tests of the physical properties of each series of alloys made up, and which would have given really very little additional information of value from a practical consideration of their application in dentistry. Their physical behavior, when drawn out under the hammer or through draw plates, together with microscopic examination, gave sufficient evidence as to their probable value. If certain alloys passed these first tests, their general physical properties and chemical behavior during corrosion tests were noted. The corrosion tests were made in different acid and alkali solutions, and also in saliva solutions. In determining the corrodability of an alloy it was placed as one element of a series of couples, e. g. with gold, zinc, Pt., etc., in order to reproduce as nearly as possible such conditions as would be found in practice. The results of experiments started under another division, gives quantitative values for the corroding tendencies of different materials, and when complete will be of very great value in that they should decide definitely the question of what metallic combinations are permissible in dental work.

It is apparent that systematic work on ternary and more complex alloys should not be taken up until all information and data regarding the binary alloys employed in these different systems has been collected. Several of the binary silver alloys give promise of being a suitable foundation on which to base a ternary investigation, especially the silver alloys. None of this series would seem, however, to promise much in the line of a hard steel-like material for posts and pins. For cast filling purposes, the alloys of silver with cadium, zinc, tin, and a few others possibly, may be adjustable to require conditions. Reference to the amalgams has been purposely omitted, as work along this special line will be taken up later. Very little data is available with reference to the alloys of silver with osmium, iridium, ruthenium, etc., and owing to the costliness of these elements, they were not included in the experimental work.

A proper summary of the results of the investigation of any series of alloys in connection with this work should consist, perhaps, in a concise statement of what has been accomplished to benefit the members of the dental profession. Although research has been especially directed, during this year, to the solution of the Pt.-Ir. substitute problem, other applicable properties of any alloys tester, cannot be overlooked.

Recent statistical reports indicate that one-third of the world's platinum supply is used by the dental profession and hence is lost. A part of this is in the form of thinnest foil, which is used for the purpose of taking various impressions. This material must be especially pure, and as such, often costs as much as $80.00 per ounce. Under the silver-palladium head was brought out the fact that these alloys were very soft; were very resistant to corrosive and sulphid-

ing influences, and also that the m. p. could be varied between that of silver, 960.° C, and that of palladium, 1550.° C; depending upon the relative amounts of each present. In spite of the fact that all records of previous experimentors state these alloys to be quite hard, they were found to be practically as soft as Pt., when reduced to thin foil. At first they require frequent annealing.

As all metals are usually listed at cost per pound, or per ounce, a very erroneous idea is generally prevalent as to the actual relative cost of the different available materials, when applied to a given purpose. A certain tooth cavity, for instance, will require a certain volume of material, and is independent of the weight, which depends directly upon the sp. gr. or density of the filling material. Suppose the volume of this cavity to be one cubic centimeter. To fill this with platinum will cost about $30.00; with gold, about $12.50; and with palladium, about $22.00. This is certainly not the general conception of the relation between the cost of these elements when compared by weight; gold $20.67 per oz.; Pt. $48.00 to $60.00; and Pd. about $60.00 per oz. This same relation holds good for any of the materials used in dentistry, a certain volume being necessary in all cases, irrespective of the weight.

Referring again to the Ag-Pd. series; an alloy of about 25.% Pd-75% Ag. will have a melting point of about 1200.° C, and can be made for about $5.50 per cc. A 42.% Pd.-58.% Ag. alloy will melt at about 1300.° C and will cost about $9.00 per cc. With 63.% Pd.-37.% Ag. the melting point will be about 1400.° C. and will cost about $12.50 per cc., or the same as pure gold, but with a m. p. of over 300.° C. higher.

Tests made showed that the material melting at 1200.° C. could be used for taking an impression of a cavity and have the gold fused or cast directly into it.

ALLOYS OF GOLD

The alloys of gold with the base metals, with the exception of copper, have never been of much importance in the arts or industries. Gold has an abnormal tendency to form complicated compounds with most of the less metallic elements, and so produce alloys, which, from the point of view of their mechanical properties, are worthless. Their constituents are clearly shown in the accompanying equilibriums. As is seen, small amounts of Al., Bi., Cd., Sb., etc., greatly lower the melting point of gold, and in many cases are combined with gold to form easily fusible solders. The mechanical possibilities of these alloys have never been worked out, in the special case of their application to dentistry, and so it will hardly do to limit the probabilities, in theory only. The alloys of, say Al. Au. or Ni-Au. may show properties of special value in this connection.

The alloys of the Gold-Copper series are quite widely used, as are those of the Gold-Platinum series. However, very little has been done in connection with this latter series in the way of determining the relation of their physical properties to chemical composition or the relation of mechanical treatment to physical properties. For instance, no method or retaining or restoring the temper, or springiness, of certain dental appliances after annealing, or soldering, is known. The melting points of the Au-Pt. series increases quite rapidly from gold to platinum, as is shown in diagram Fig. 27. All of these alloys are harder than pure gold, while those of about 50% Pt. are harder than pure Pt.

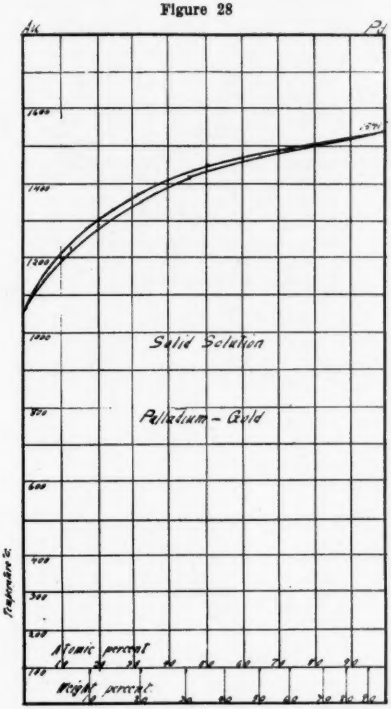
Gold Palladium. Fig. 28.

There is practically no evidence on record regarding the mechanical properties of these alloys. This series has been investigated rather thoroughly during the past year in this laboratory, and without going into a detailed description,

their value may be summarized as follows:

The addition of small amounts of Palladium to gold causes a greater rise in temperature than does a like amount of Pt., so that a certain fusing tempera-

Figure 28



Gold Series.

ture is reached with less cost by using Pd.

The Pd-Au., alloys are very soft and ductile, much more so than those of the Pt-Au. series.

A small per cent of Pd. in gold foil increases its melting point to such extent that it can be used for foil impressions, and cast and fused fillings made directly therein. Foil for this purpose is as soft as pure gold, and is much softer than Commercial Pt. foil.

One per cent of Pd. darkens gold perceptibly, while those alloys of 2% to 3% are a bronze color. At 5% Pd. the alloy is almost the color of silver, and above that point the color of Pd. is present.

Tests made, show these alloys to be absolutely unaffected by chemical compounds of the mouth.

They will solder as well as pure gold, and without being so easily fluxed, or melted.

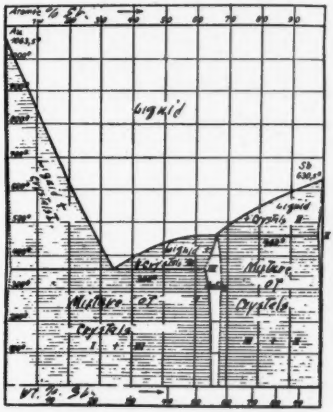


Fig 29 Gold Antimony.

This foil is well suited for baking porcelain upon.

The alloys of gold, with antimony, bismuth, copper, lead, magnesium, nickel, thallium, platinum and tin, show characteristic physical properties which are easily read directly from the temperature and physical charts, (figures Nos. 29, 30, 31, 32, 33, 34, 35, 36, and 37) and while they do not offer substitutes directly for platinum alloys, the information contained in these charts will be of value to the dental profession in later researches in the ternary alloys. We are, therefore, including them with the binary alloys in their proper place in the text.

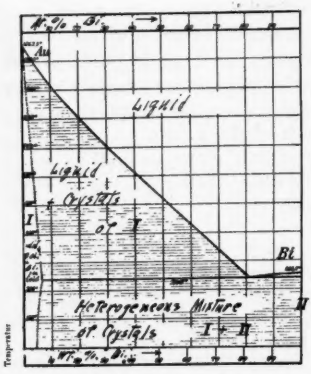


Fig. 30. Gold - Bismuth

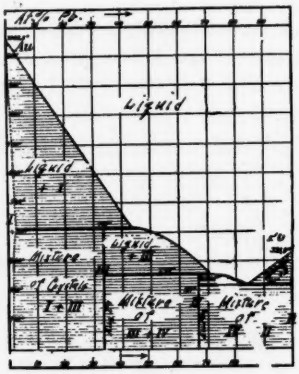


Fig. 32. Gold - Lead

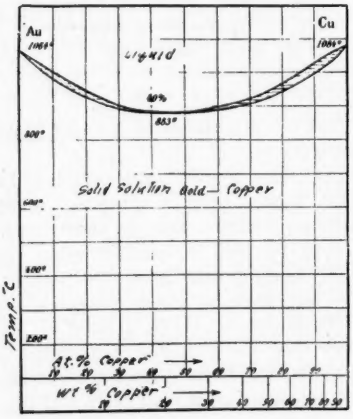


Fig. 31 - Gold - Copper

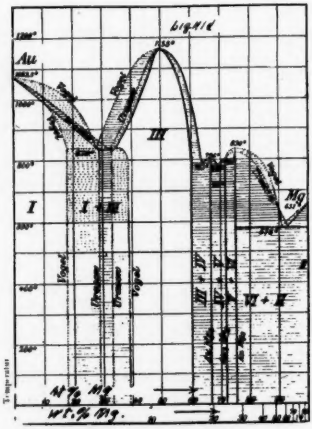


Fig 33 Gold - Magnesium

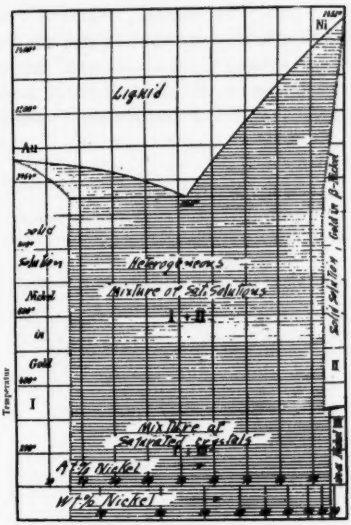


Fig. 34 Gold - Nickel

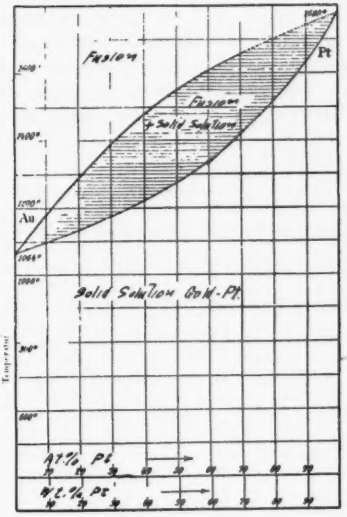


Fig 36 Gold - Platinum

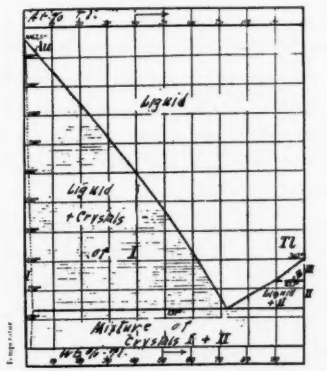


Fig 35 Gold - Thallium

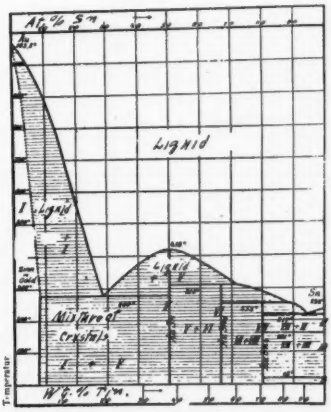
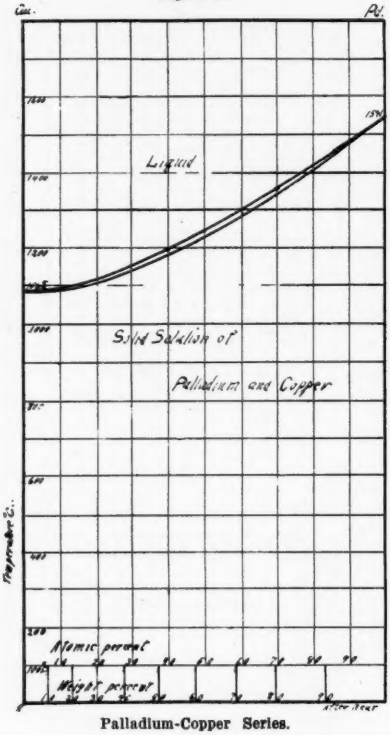


Fig 37 Gold - Tin

PALLADIUM.

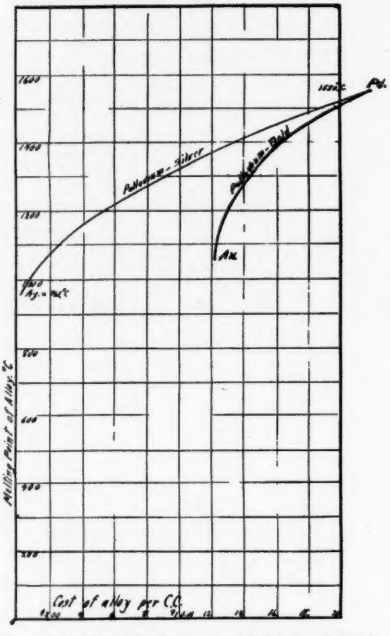
On account of its high resistance to carrision and sulphiding influences, palladium has long been used for making or coating the works of high grade chronmeters, for making parts of very sensitive balances, and for electroplating reflecting mirrors of high grade telescopes. Its general properties are too well defined in any standard text on chemistry to take space for that purpose here. Suffice to say that it is insoluble in mineral acids, except strong HNO_3, and is unattacked by organic or alkali reagents in general. The remarkable properties of Pd from a metallurgical point of view, is its great solvent power for other elements, forming solid solution in perhaps more cases than any other element. This feature, coupled with its other valuable physical properties, makes this a particularly promising element for our purpose. With many of the metals of low m. p. its alloys are also of low m. p. except those of high Pd. content. This is true in the case of Zn. Sn., etc. Some of these, however, may be modified so as to be suitable for a casting material. In this present report only those combinations will be taken up that would promise a fairly infusible (above at least 1200.° C and non-corrodable alloy.

Figure 38



Palladium-Copper Series.

Figure 39



Curves showing relative cost of Pd-Ag and Pd-Au alloys having equal melting points.

Pd.-Ag.—These have been described under Palladium.

Palladium-Copper, Fig. 38.

Copper, with palladium, forms a completed series of solid solutions, as would be predicted, providing the properties of both Cu. and Pd. These are splendid soft, ductile, alloys whose properties parallel those of the Ag.-Pd. series. The Ag. Pd. alloys, however, are superior in every way, apparently, in that both components are noble metals, and hence form alloys which are much more "noble" in their properties. Even if the melting point was the criterion, the silver-palladium alloys have the advantage, in that a certain m. p. is reached with a smalled relative addition of pd. than is necessary with copper, thus in every way, so far as considered in this work, the Ag. Pd. alloys will take the place of corresponding Cu. Pd. alloy, at a smaller cost of production and with more valuable properties.

Figure 39 shows curves giving graphically the comparision of the cost of production of Pd-Ag. and Pd.-Au. alloys of a given m. p. This gives the advantage to the Ag. Pd. series. By reading across from any desired temperature to the respective curves and then following down the perpendicular to the base the cost is read directly.

Palladium-Nickel.

The melting points of alloys of this series average apparently (no means was available for measuring the temp.) between that of nickel and Pd.

All alloys of this series are ductile and malleable, and those of above 30.% Pd. are not readily oxidized. They are all softer than nickel and hence do not offer a pt-Ir. substitute. The foil would be inferior to Ag.-Pd. or Au. Pd. for dental purposes.

Palladium has proven to be a good solvent for nickel, iron, chronium, etc., so naturally its solubility for tungsten and molybdeum might be inferred. Experiments have proven this to be true. The addition of W. or Mo. to Pd., however, seems to offer no special properties of value. The opposite was shown in specimens made up, but this points to possibilities along a different line of attack, as will be taken up under tungsten and molybdenium.

The temperature and physical charts for other alloys are given here in the

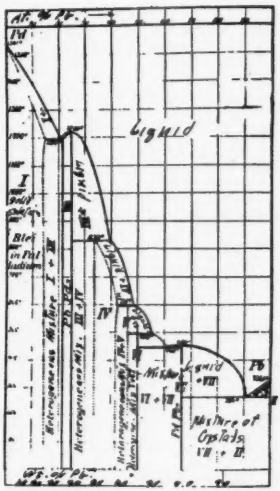


Fig. 40 Palladium Lead

binary group for later reference, as follows:

Palladium and lead, Fig. 40.
Platinum and iron, Fig. 41.
Platinum and lead, Fig. 42.
Platinum and Thollium, Fig. 43.
Platinum and tin, Fig. 44.
Platinum and Antimony, Fig. 45.
Platinum and Copper, Fig. 46.

So far, no binary alloy of the common metals has given promise of being successfully substituted for the iridio-platinum "hard metal". However, in the

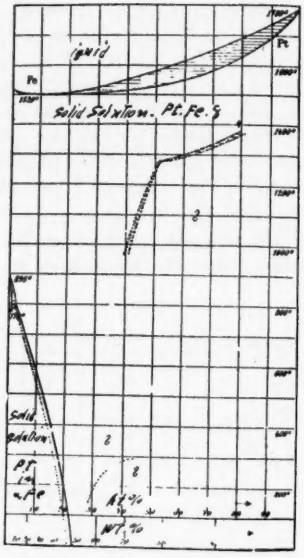


Fig. 41 Platinum - Iron

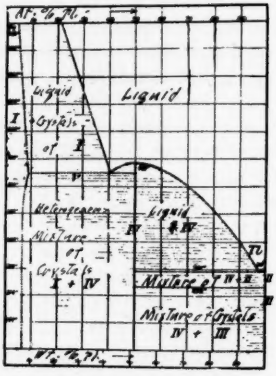


Fig. 43. Platinum - Thallium

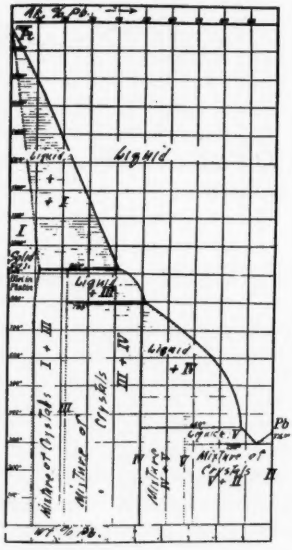


Fig. 42. Platinum - Lead

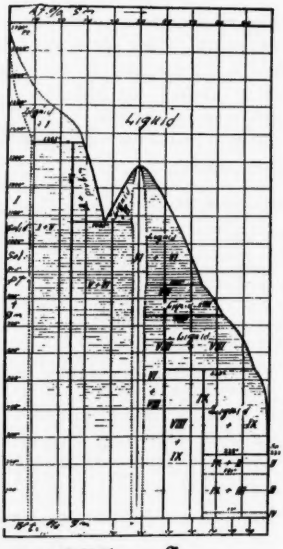


Fig 44 Platinum - Tin

work carried on Pd. and Pt alloys, during the past year, several discoveries have been noted, and our field of possibilities thereby enlarged, chiefly among the elements regarding which little is known and which present a new field for research as to their application, these are Tungsten and Molybdenum.

Tungsten is popularly known only in its application in the manufacture of incandescent lamps. The newly developed

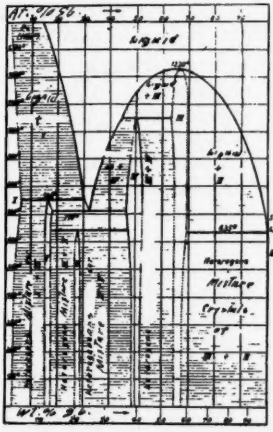


Fig 45 Platinum-Antimony.

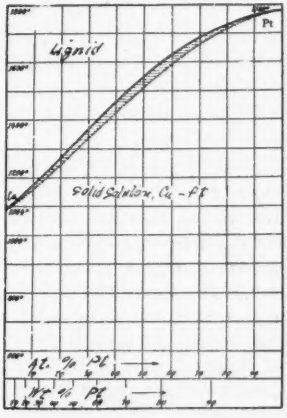


Fig. 46 Platinum. Copper

ductile metal is practically insoluble in any of the common acids, its melting point is higher than that of any other metal, its tensile strength exceeds that of steel, it is para-magnetic, it can be drawn to smaller size than any other metal, and its specific gravity is 70% higher than that of lead.

Wrought tungsten has been substituted with success for Pt. and Pt-Ir. as contact points in spark coils, voltage regulators, telegraph relays, etc. The service for exceeds that for Pt. and Pt-Ir. contacts, due to greater hardness, higher heat conductivity, and lower vapor pressure as compared with Pt.

Electric laboratory furnaces with W. (tungsten) resistors are of two types; in one a W. wire is wound on an alundum tube in an air-tight box in an atmos. of H.; in the other a tungsten tube takes the place of the helical resistor in the Arsem vacuum furnace. Tungsten gauze is used successfully for filtering acid liquors, and where fumes are encountered. Tungsten is also well suited for standard weights since it can be made so hard that it will scratch glass and still be ductile. The density is also high, and it is unaffected by the atmosphere.

Among other applications partly worked out, or suggested, is for galvanometer suspension, cross hairs in telescopes, strings for musical instruments, etc. It has also been suggested to use the fine wires in surgical operations in place of the coarser gold and silver.

Acid proof dishes and tubes are also made of tungsten. Since W. is paramagnetic and is very elastic it may be used for springs for various purposes. Out of this material watch springs could be

made which would never become magnetized.

Tungsten pen points, drawing dies, knife blades, etc, are also possible.

The following gives an outline of its general physical and chemical properties:

Density=19.3-20.2.

Tensile strength,=322-427 Kg. per. sq. mm. (up to 650,000 pounds per sq. in.

Young's modulus of elasticity,= 42,000.00.

Steel=20,000.00.

Thermal conductivity=0.35 gm. cal. per. sec. per. degree cent. (Pt. =0.166).

Coefficient of expansion=4.3 times10^{-6} 4.3 times 10(Pt. =8.8-6).

Resistivity, 6.2 ohms per c. c. (hard); 5. ohms (soft-anneale).

Temp. coef. of res. =0.0051 (0.170° C.)

Hardness, 4. 5-8.0 (Mohs scale.)

Relative to the chemical properties of tungsten, the following is taken from a paper by W. F. Ruder, J. Am. Ch. Soc., 34,387. "In the following experiments the samples of metal used were all of the same shape and size. They were discs, of sheet tungsten, such as are now being used for X-ray targets, and are 18 mm in diameter by about 2.5 mm. thick. The surface area was 650 sq. mm. on the average. The weight according to thickness, was 9. to 12. grams.

Solubility in HCl wrought tungsten is insoluble in hydrichloric acid of and concentration at room temperature and only slightly so at 110.° C. After 45. hours the hot concentrated acid showed no effect upon the tungsten. After 175. hrs., however, the material was covered with a coating of oxide and the metal lost 0.5% in weight. In dilute acid at 110.°, it lost 0.05% after 22 hrs., but showed no further loss after 50. hrs. After 175. hrs. the metal was coated with tungstic oxide and there was a gain in weight of 1.% due to oxidation. This oxide formed an adherent coating protecting the metal against further loss.

Solubility in H_2SO_4. At room trmp. this acid has no effect upon wrought W. nor has the dil. acide at 110.°. Concentrated acid attacks it very slowly at 110.°, the loss in weight being 0.1% after 18 hrs. and 0.16% after 40. hrs.

Solubility in Nitric Acid.

Concentrated nitric acid at 110.° showed no action on tungsten after 48. hrs., other than a dulling of the bright metallic surface. The dilute acid, however, produces the yellow ovide on the surface. There is a slight gain in weight after 15. hrs. and then no further change after even 175. hrs. immersion.

Solubility in Aqua-Regia. Aqua-Regia at room temperatures, oxidize the surface to tungstic oxide. After 215. hrs. the loss in weight was .31%. If this coating is allowed to remain, continued boiling with fresh equa-reria had not further effect upon the metal.

Solubility in Hydrofluoric Acid. This acid, hot or cold, did not attact tungsten, even to the extent of dulling its polished surface, during frequent evaporations of the acid.

Solubility in Potassium Hydroxide. Potassium hydroxide solution of any concentration does not attack tungsten but the fused alkali attacks the metal slowly. In this case there was 21.= loss after 15. hrs., and after 40. hrs. the disc had all dissolved.

Solubility in Alkali Carbonate. In fused alk. carbonate, potassium carbonate, or mixtures of the two, tungsten dissolves slowly. About 2.5% was noted after four hrs. Addition of KNO_3 hastens the solution considerably.

In other experiments a saturated sodium hypochlorite solution was found to attack tungsten at the rate of about 4.% in 24 hrs. A mixture of H_2SO_4 and chromic anhydride did not act upon the metal. A mixture of hydrofluoric and nitric acids dissolves tungsten very rapidly with evolution of nitric oxide and the production of tungstic oxide. Exper-

iments made in this laboratory has shown that tungsten is quite soluble in hydrogen peroxide, and this action is hastened by the presence of NH_4OH.

The following is taken from the same paper by W. F. Ruder as that above, on tungsten. "In the following experiments small strips of molybdenum, 30.X9.X.4 mm. were used, having a total surface of 540. sq. mm.

Hydrochloric Acid, diluted, slowly dissolves molybdenum, at 110.° to a brown solution with some black oxide, probably M_2O_3. The loss in weight was 20.% after 18. hours. The more concentrated acid has a much slower action. After keeping the metal in acid of 1.15 sp. gr. for 18 hours at 110.° the loss was only .34%, and the surface was still bright.

Sulphuric Acid, diluted, at 110.° does not attack Mo. The concentrated acid (1.82) does attack it very slowly at this temperature. Only 0.29% was dissolved after 18. hours. With elevated temperature, however, (200.-250.° the metal dissolves rapidly to a green solution, with evolution of SO_2.

Nitric Acid, concentrated (140) dissolves Mo. slowly with the formation of MoO_3, which deposits on the surface of the metal, retarding further action. The more dilute acid (1.15) attacks the metal rapidly.

Aqua Regia also dissolves the metal rapidly, especially if heated.

Hydrofluoric Acid (hot or cold) does not attack molybdenum.

Potassium Hydroxide solutions do not attack Mo. but it is soluble in the fused alkali.

It will be noted that both W and Mo. are, to a certain extent, acid resisting, and this is due principally to the formation of an acid resisting coating of oxide. Tungsten is attacked most readily by fuming H_2SO_4 and this only to the extent of 1.2% in 8 hours. Molybdenum is much more easily dissolved than tungsten. It resists concentrated HCL and H_2SO_4 at moderate temperatures fairly well and is untouched by hydrofluoric acid.

With two exceptions, this metal is superior to any Iridio-platinum alloy possible. These properties of tungsten which make it unsuitable for dental purposes are: its oxidation at soldering and casting temperatures, and its practically zero affinity for gold, silver, etc., at ordinary temperatures.

During previous investigation it was discovered that both W. and Mo. were easily soluble in palladium and less so in platinum. This led to the partial investigation of these series, which did not promise much in the way of an alloy. It does, however, open up a new field. If tungsten is so soluble in Pd. why not put a coating of Pd. on the tungsten wire, thus combining the valuable properties of W. as to tensile strength, low coef. of expansion, hardness, etc., with those of Pd, which can be readily soldered, is not oxidized, or affected chemically during manipulation and while in use.

Experiment along this line led to the production of such a wire. Further work proved that the Pd-Ag. or Pd-Au alloys of sufficient Pd. content, could be used as well as pure Pd. Using this alloy, very little is added to the first cost of the tungsten itself.

This coated wire should serve as a more desirable material than Pt. or the Pt-Ir. alloy. This coated wire cannot be softened by repeated heating to ordinary temperatures (i. e. heating does not remove the temper or springiness as is the case with other materials). It has many times the tensile strength of Pt-Ir. and has six times the bending strength of a 30% Pt-Ir. wire of the same size. It can be easily soldered or cast onto; it will not oxide or be affected chemically. The wire cannot easily be deformed while cold, but if heated in the open flame slightly it can be bent to any desired shape.

The Availability of Tungsten.

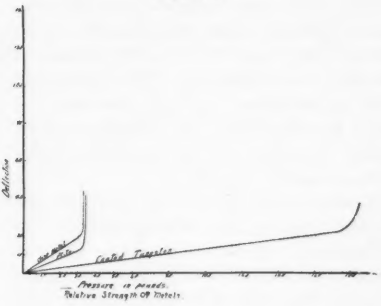
The enormous amount of detail, incident to these studies, and very large difficulties to be overcome have made it impossible in the limited time to bring these studies to a degree of perfection where we can state positively relative to the price of metals and their combinations, or of the purity and constancy of their properties as they will first become available. It has been impossible, most of the time, for us to get tungsten for our researches, not because of its scarcity but because of the care with which it is guarded. It is used, as is generally known in the manufacture of lamp filaments and since it draws into such infinitely fine wire, one-thousandth of an inch or less, a relatively small piece of tungsten rod would make enough of the filament for one thousand dollars worth of tungsten lamps. Its manufacture is guarded both by patents and secret process and the sources from which it can be secured in this country seem to be limited to the General Electric Company. It was only by making a special trip for a conference with the management that we were able to arrange for its commercial use by the dental profession, as well as secure samples for our research work. It will be necessary for the tungsten to be cut into lengths, probably not exceeding three or four inches, before it can be marketed to our profession. The general Electric Company will not sell it direct to individuals of the profession but after your research department has endorsed a quality of material, they will make it available to the dental jobbers. It is exceedingly difficult to change tungsten from the powdered form, in which it is easily obtained commercially, to the metallic bar and wire. The change is accomplished by compressing the powder under the high pressure, producing a rigid rod through which an electric current of high amperage is passed, thereby heating it to a very high temperature, in which condition the particles, though not fused, are sufficiently softened so that under the swaging process the particles become attached and the piece takes on a metallic appearance. It is then heated and while hot drawn through drawplates, which in effect elongates the particles or grains. This must be done in an atmosphere free from oxygen. The more it is drawn the more ductile it becomes, though at all times it must be drawn hot until small sizes are reached, though after it becomes more ductile it need not be even red hot. The physical property of the final bar, when crushed or broken, is that of bundle of small thread like crystals and the strength of the final bar depends quite largely on the number of drawings and may range from a hardness and stiffness exceeding that of hard steel to a softness comparable to medium steel wire. In its harder form it withstands abrasion probably better than any known metal, as is illustrated by the fact that a reproducing point for a phonographic needly, when made out of tungsten, will outwear two hundred of the standard hard steel points. This indicates a great possibility for this metal for the future as a cutting tool for dental uses, however, a very great difficulty in its manufacture arises out of that quality. Grades of tungsten that are as hard as the above are very difficult to mall and require to be ground. It is not improbable, however, that all these difficulties will be overcome.

We have spoken in the first part of this report of the enormous strength of tungsten as compared to that of other metals, it having a tensile strength thirty times that of gold and five and one-half times that of iron. It is practically uneffected by the acids or by fluids of the mouth and specimens that we have placed at the points of abrasion on the occlusal surface of fillings have shown a phenomenal resistance to wear. The melting point of tungsten is so enormous-

ly high, namely, over 3000° C. and 5400° F. that it is exceedingly difficult to fuse other metals on to it under ordinary conditions. This, however, can be done readily by methods which we shall review. While tungsten so perfectly resists oxidization at ordinary temperatures, it does oxidize rapidly under an open blowpipe flame at high temperatures, thus making it impossible to flow the ordinary metals on to it under ordinary conditions, even though they do so readily when in a non-oxidizing atmosphere. Consequently, it is not difficult to coat the tungsten perfectly with any of the suitable noble metals, or combinations of them, and the golds and solders can be readily flowed on these with the ordinary blowpipe flame. For this purpose pure gold, or preferably an alloy of pure gold, and palladium answer admirably, though silver and palladium is satisfactory. This coating is so thin that it need not add more than one per cent to the weight and, consequently, adds very little expense to the cost of the tungsten. The tungsten bars thus coated will probably cost from fifteen to twenty per cent as much as platinum to start with and if the judgment of metallurgists is correct, the price of tungsten must go down to a few dollars a pound.

Figure No. 47 illustrates in chart form the relative strength of the coated tungsten bars to that of iridio-platinum and of clasp metal of the same sizes. The horizontal line expresses an increase up to eighteen pounds and the verticle line illustrates deflection in tenths of an inch before bending and the pressure at which bending occurs or where elasticity is overcome. The length of these bars between supports was one-half inch. The clasp metal and iridio-platinum both bend at a trifle over three pounds at one and one-half and two-tenths inches deflection respectively, and the coated tungsten bent at eighteen pounds at about two-tenth deflection, giving tungsten approximately six times the stiffness of the iridio-platinum or clasp metal, which means that the factor of safety, when a bar of the same size of tungsten will be used as a post for a crown, would be six times as great as when iridio-platinum or clasp metal are used, and also means that a much smaller size post may be used and still have a much greater strength. All will recognize the very great advantage of this in small rooted teeth, like upper laterals, and all lower incisors. Also for individual roots of molars where great strength is required and the tooth structure material is already the minimum and elas-

Figure 47



ticity by being heated to ordinary temperatures which quality suggests a large usefulness for orthodontia appliances and for which use we are making studies, which will be reported later.

We have found tungsten as coated to be a very great advantage as a frame work into which we will cast cold alloys and thus hold gold from distortion due to its natural contraction. In other words controlling the location of the contraction by actually stretching and holding the gold. We have found that bridge abutments made of the coated tungsten, consisting of posts entering roots and united with bars of coated W by means of high fusing gold and platinum solder, will permit of the wax being moulded directly around this frame work, includ-

ing the inlay restorations for the abutments and the facings in position, and after the removal of the facings the entire piece cast at once with only a fraction of distortion produced when the same coating is made without this frame work. It is desirable for this use to use a threaded bar, or one specially roughened, to prevent the gold from sliding upon it. These bars are similarly used and with great advantage in controlling the contraction of MOD restorations, as previously announced. Molybdenum has some very desirable qualities and some less so. It is naturally much softer than tungsten but like tungsten is oxidized at high temperatures in the open blowpipe flame and requires to be coated with some of the noble metals, as we have just suggested. Our researches will be continued with it and reported more in detail later. It probably will be made a component of a ternary alloy with splendid qualities.

There are many reasons why our profession should make extensive use of palladium. In the first place because volume for volume it is about one-third cheaper than platinum. Its relative density, as compared with platinum, is approximately as eleven is to twenty-one, which means that when you buy an ounce you get approximately twice as many square inches, or linear inches, according to the form of the material. In color, surface and softness it compares very favorably and while its coefficient of expansion is slightly higher, namely, as eleven is to nine approximately, it is very satisfactory for many uses with porcelain. While we have not done so we are informed that porcelain dentures have been baked on it with beautiful success, it apparently behaved in every way as satisfactory as platinum. There is reason to believe that it may come to be one of the most used metals in dentistry, largely because of the fact that it enters into perfect solution with nearly all metals and in which record it stands unique among metals. Its present cost of approximately $60.00 an ounce, or $22.00 a cubic centimeter, will probably be very greatly reduced in the near future and we have been advised by competent metallurgists that if a good demand can be created for this metal, it could be produced as low as $10.00 an ounce. It is a by-product in the production of copper and has very little demand. The dental profession alone could use enough of it to warrant competent capitalists making special efforts to increase the supply. The alloys of palladium and silver and palladium and gold have so important a place in modern dental practice that we feel confident that those who use them will continue their use, both because of their being so much less expensive than platinum and its compounds and because they have all the softness of pure platinum in practically all proportions of either palladium and silver or palladium and gold, provided the ingot is frequently annealed during its first rallings. Palladium and silver, though both are white metals, have a slight but beautiful lemon tint when polished and the palladium has the remarkable property, not only of very rapidly raising the melting point of gold but of very rapidly absorbing its color so that ten per cent by weight, (not volume) of palladium and gold not only increases its melting point from 1065° C. to nearly 1300° C. but produces an entirely white metal like the palladium itself. This proportion can be used almost any place that platinum foil will be used as a backing for gold and would cost a little over $14.00 a cubic centimeter, considerably less than half the price of platinum. We have found it worked beautifully for taking impressions for porcelain inlays and for matrices for which to flow, or cast, gold in various other uses for which platinum is adaptable. The addition of even one per cent

of palladium to gold increases its tensile strength very greatly and even two or three per cent will raise the melting point sufficiently that when gold is cast upon it it unites without melting it, thereby producing a margin which, though practically as soft as pure gold for burnishing and finishing to the tooth, is much stronger and tougher than the 24K gold and likewise more pliable than the 20K gold, or less. Its use as a gold plate has some distinctly desirable qualities. The palladium can be purchased in the open market from the dealers in platinum and noble metals and should be supplied to the profession without difficulty. It is destined to have an important place in dental metallurgy as a ternary alloy, in which role it will be reported later.

METALLURGY.

(Closing Sentences.)

The director of these Metallurgical Researches greatly desires assistance and helpful criticism from the profession, relative to those various metallurgical products, that are and may be suggested for dental uses, and will undertake to send samples to such as shall desire them, with the understanding that we are to have the benefit of your helpful criticism and the expense incidental to preparing and sending the samples. We shall, also, be glad to advise all members of the trade where and how they may secure and prepare these products, upon request for this information. We shall expect to furnish additional information in these columns as fast as it becomes practicable.

SPECIAL RESEARCHES IN PHYSICS

By Weston A. Price, D. D. S., M. S.

(Read before National Association at Rochester, N. Y., July 7, 1914.)

THE special physical researches that have been conducted during the past several years in this office on the properties of waxes, investment materials and metals have been continued and have consisted, chiefly, during this year, in repeating the studies made previously to narrow the margin of former errors and to correct rather than to verify. We acknowledge the assistance particularly of Mr. Frank A. Fahrenwald, Professor Dayton C. Miller, Professor of Physics of Case School of Applied Science, Dr. Thomas J. Hill and Dr. George A. Shilling. Only a small part of the expense for these researches during this year have been met by the Commission. The results, however, are cheerfully given to them.

The coefficient of expansion of the waxes, as previously reported by the writer, (see Dental Cosmos, March 1911*) has been checked over and the change in the coefficient, with the increase of temperature, or progressive increase in the rate of expansion, has been carefully noted and tabulated. Some waxes that have been put on the market more recently than the time of the original studies have been added to the list. By comparing the results in table No. 1 of this issue with table No. 2, page 271, of the previous article above referred to, you will note the great similarity in the readings, which indicate, chiefly, that the waxes with corresponding names and readings have practically the same formula, as the samples secured in the open market some years ago. Several of the former waxes have been withdrawn from the market and several new ones are available. A word of explanation will probably make the table more easily interpreted. All are familiar with the fact that pattern and impression waxes have a considerable range of temperature through which they may be moulded and worked but which ranges vary with different formulas. The two columns of temperatures underneath the general heading of "Approximate Working Range" indicate respectively the lowest and highest temperatures, bounding the range through which that particular wax can be moulded. The center column indicates the change in linear dimension (which is one-third the volume change) which takes place between the lowest working range and room temperature in the wax in question. The second column from the reader's right, while called ex-

Figure 1

Wax	Approximate Working Range Min.	Max.	Contraction from Min. working range to 68° F.	Expansion from 68° F. to Max. Working range	Excess of Expansion over Contraction
S.S. White (Inlay)	116°	130	1.06%	1.52	0.46
Standard Inlay wax	118	135	1.42	3.47	1.97
Standard Dental	108	135	1.30	3.97	2.67
Ideal	110	130	1.30	2.90	1.60
S.S. White (Mod.)	116	135	2.08	3.50	1.42
Purity	100	120	1.48	1.90	0.42
Kerr	109	125	1.40	2.93	1.53
Consolidated	115	131	1.50	2.76	1.26
Conlee	113	130	1.35	2.41	1.06
Security	113	130	1.45	2.69	1.24
Taper (Insertion)	97	107	1.41	1.91	0.50
Carnauba	104	123	0.65	1.35	1.10
Cosmic	95	113	0.75	1.73	0.98
Non Diffuse	109	122	0.67	1.69	1.24
Stacia	109	122	1.00	1.52	0.52
Taggart (green)	109	130	1.10	2.10	1.00
Van Horn	113	130	1.25	2.75	1.50

*"The Laws Determining the Behavior of Gold in Fusing and Casting."

pansion, expresses the same dimension changes for the additional range in temperature up to the maximum working temperature and will be the same amount whether it is a cooling process or a heating process. The last column at the right expresses the difference, or the expansion, or contraction, taking place between the working limits of temperature. It will readily be noted that this dimension change within the working range varies from half of one per cent linear to two and one-fourth per cent linear, according to the wax. For those who are not familiar with the significance of this data and the enormous advantage or disadvantage it may be in the operations of making dental castings, we will review, briefly, the processes in which it is involved. When the wax pattern material is placed in the cavity at a temperature at which it is just plastic, see first column to the left, and is then removed from the cavity, either before or after being chilled, but finally brought to room temperature, 67° F. or 20° C.; its dimension change will be indicated in the middle column. If the wax is invested in the moulding material, usually plaster and silica, at this temperature the dimension of the mould will be in error the amount of the contraction of the wax. If, however, it is still further chilled by being invested in a very cold investment, this error will be increased. On the other hand if it is invested in a very warm investment, comparable to the upper working range of the wax (see second last column) the pattern may be brought back to its original dimension and enlarged a definite per cent above it in proportion to the formula of the wax and the temperature of the investment. (See the last column.)

Neglecting for the present the relatively small change in dimension that may be made in the investment material by heating it and passing to the process of putting the molten gold into the mould and allowing it to cool, we have with all investments (except stone hard investment materials, which may be strong enough to stretch the gold) a definite fixed contraction always present with the cooling gold, which amounts to 11.53% volume of 3.84% linear, from the time the gold is in the molten state until it is at room temperature, but of this 4.93% volume, or 1.64% linear, is due to change of state of the gold and occurs in a change of temperature of less than one degree and which expresses itself as a fault or hollow in the side of the casting, which, however, need not appear, and does not, if fresh molten gold is permitted to pass into the form and take the place of this first contraction. The larger part of the contraction of the gold from its crystalizing point to normal temperature, amounted to 6.6% volume or 2.2% linear, is always present, even though the location is disturbed by holding the mass and stretching it.

It is this large fixed error, due to the contraction of the gold after it leaves the molten state, which is the large embarrassment we have been seeking to find a solution for and which our practical results show the justification of. Since the contraction of the gold is a constant factor and of a definite amount, we may plan, systematically and definitely, to introduce an error that will precisely compensate or offset for the contraction of the gold, and whether we are so precise as to produce approximately the exact amount or not is not so important as that we work with sufficient intelligence and consistency as not to add to that fixed error, an additional amount which may even exceed that of the contracting gold, due to change in dimension of our wax pattern. We are not, in this observation, stating a new truth, or suggesting a new method or process, but reviewing briefly for clearness. For a more elaborate statement of this procedure see the article referred to above by the

writer.* Also one by Dr. C. S. Van Horn, Dental Cosmos, October 1911.** It should be clear that, if possible, we should so handle our wax pattern as not to add its large dimension change to that of the gold's fixed change, but, if possible, so thoroughly understand the wax with which we are working as to know what treatment to give it that would correct for the contraction of the gold. have been able to secure in the open market, placed in a graphic chart where at a glance we can see the fixed dimension change due to the contraction of the gold and by the side of it the available dimension change that takes place in the various waxes and which amount can largely, or in part, be added to, or subtracted from, the dimension change of the gold. These are shown in Figure No.

Figure 2

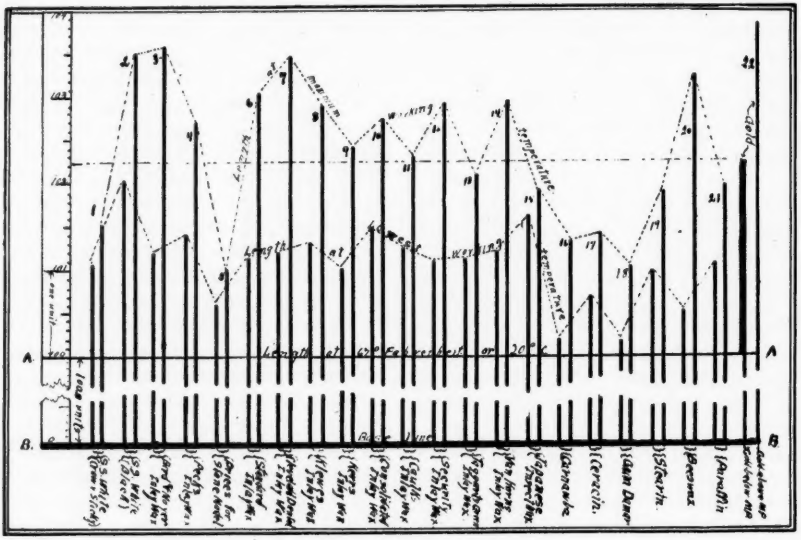


Chart showing dimension changes of inlay and impression waxes and of gold thruout their working ranges
*Below freezing temperatures, which are high

This could be read, with a little study for any of the waxes, directly from the figures in table figure No. 1 herewith and also table No. 2 in the article above referred to. But for the convenience of the profession we have had the contents of these two tables, which include practically all the pattern waxes that we 2, which is a very simple chart to read. Since all the dimension changes are expressed in per cent, we have taken a column of each wax one hundred units long at room temperature of 67° F. or 20° C. A unit can be one inch or one hundredth of an inch, or any other dimension. To save space the long column is broken, showing only its two ends, the distance between lines A. and B. representing one hundred units of length. The dimension of a unit is shown on the scale to the left in which

*Dental Cosmos, March 1911, "The Laws Determining the Behavior of Gold in Fusing and Casting."

**Dental Cosmos, October 1911, "Standardizing the Investment Process and Simplifying the Casting Process," by C. S. Van Horn, D. D. S.

it is the distance from 100 to 101, etc. Also, the actual distance between lines A. & B. Each pair of double vertical lines represents one of the waxes but a few are constituent or basic waxes used for making them. The elevation above the line A., which is labeled "Length at 67° F. or 20° C." represents the expansion which occurs above that when the wax is heated to its low working range, represented in the shortest of the two columns, and to its high working range as shown in the longer column. The two columns at the extreme left marked 22 represent the dimension changes in gold. The long column represents the total dimension change in a column of gold one hundred units long between its molten state and room temperature, namely 3.84% linears. The heavy shorter column next to it represents the dimension change between its first crystaline form and room temperature, or 2.2% linear, and the difference between their lengths, the dimension change due to change of state from liquid to solid, namely, 1.64%. These two columns are marked gold. The names of the respective waxes are given below the base line and the columns are numbered above. The dotted line extending across the chart from the level of the shorter double blacked gold column to the point 102.2 on the scale indicates the amount of expansion that would require to be used with each wax if we were to just compensate for the fixed contraction of the gold. The names of the waxes from left to right are:

1. S. S. White Crown Sticky.
2. S. S. White Black.
3. Bird & Moyer Inlay.
4. Peck's Inlay.
5. Price's for Stone Model.
6. Standard Inlay.
7. Cleveland Dental Inlay (old formula).
8. Klewes Inlay.
9. Kerr's Inlay.
10. Consolidated Inlay.
11. Caulk's Inlay.
12. Security Inlay.
13. Taggart's Crown Inlay.
14. Van Horn's Inlay.
15. Japanese Insect.
16. Carnawba.
17. Ceracin.
18. Gum Damar.
19. Stearin.
20. Beeswax.
21. Paraffin.
22. Gold.

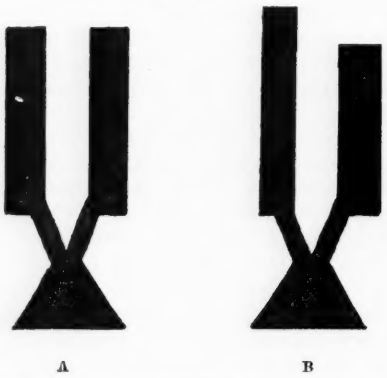
The Asterisk on Carnawba and Gum Damar indicates that their softening points, which are high, were not reached at the temperature used.

It will readily be seen from this chart that many of the waxes do not have sufficient change to offset or equal that of the contracting gold, while several others have more than is necessary if in any case it could all be utilized. Note particularly that several have relatively a small difference in dimension between their high and their low working range, which is clearly the part that can most easily be made use of. Others have a very large dimension change between these points. Let us for illustration apply the information in the chart to practical procedure. No. 1 is not a pattern wax, yet many dentists use it for taking impressions because of its great strength. If we were to take it from the cavity at its low working range and cool it to room temperature and invest at that temperature and cast, we will carry forward 1% contraction error to add to our 2.2% of the gold. If we heat this wax to try to put in an error of expansion to offset the gold's contraction, we can only get half of one per cent above the dimension at which we removed it from the cavity. If we make the same tests with wax No. 2 we may either add two per cent to the error or we may take out 1½%, or even more, up to 3% if we use nearly all the available expansion. With No. 3 the difference between the dimensions at low and high working range is 2.4%, or more

than enough to offset the gold contraction. If Nos. 2 or 3 were removed at a temperature near their high working range and invested in an ice water investment, a contraction error of over 3% could be carried forward to which that of the gold would be added, making a total of 5%. If, on the other hand, these same waxes could express, by their volume, the exact dimension of the cavity when they were at a temperature of 67° F. and could then be heated to their high working range and invested, they would produce a mould 3.5% larger than the cavity which, when the gold was cast into it and contracted its fixed 2.2%, would produce a cast still 1.3% larger than the cavity. These results can readily be produced, as will presently be shown. There is no doubt that many of the profession have been introducing an error with their wax, thereby increasing that of the contraction of the gold and probably not infrequently doubling it.

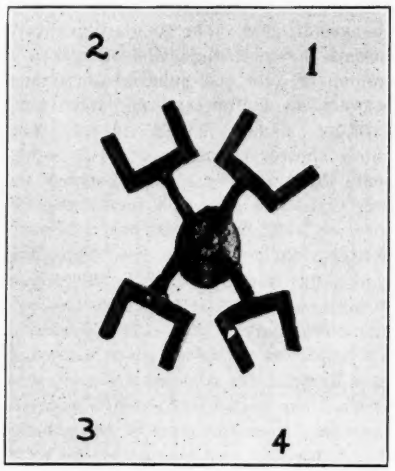
This would seem to be an ideal and simple way to correct for the fixed contraction of the gold and is, if the next distortion error is prevented from entering, which arises out of the elasticity of the wax. Figure No. 3 demonstrates this, as does also Figure No. 4. In Figure No. 3 we have two cast columns of gold both attached to the same sprue and hence from the time of investment they have had the same treatment. These two bars differ 18% in length, yet they were cast at once from wax patterns which were the same length. All waxes are more or less elastic when heated to their low working range. Any one can produce the error shown in Figure 3 as follows: Take two pieces, or bars, of inlay pattern wax, (These were made from Cleveland Dental—their old formula) and place them in warm water and heat to the low working range. Take one of the bars out and stretch it and while holding it plunge into cold water to chill, and thereby retain the elasticity. Then take the other piece and do the opposite by condensing it endwise and chilling. While cold cut a piece one inch long from each and attach to a sprue. Mix the investment with water at the temperature of the high working range for the wax used and invest. When you last see

Figure 3



Two similar wax bars placed in a warm investment and cast. A, Before heating. B, After heating.

Figure 4



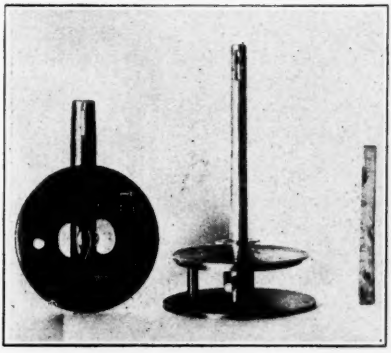
the waxes they are the same length but the warm investment releases their elasticity like the thawing of a frozen stretched rubber band. Each relaxes to its normal molecular state of rest without strain. The elongated one shortens and the shortened one elongates. It is true that these are extreme conditions, however, there is abundant evidence that in a considerable degree this error enters into much of our technic. We are liable to be misled and conclude that this is an extreme test and, therefore, not comparable to dental precedures, and particularly that it would be impossible to produce any considerable elastic distortion in the production of an MOD restoration. Figure No. 4 clearly demonstrates that it is possible to very simply introduce this error in our ordinary technic, for all four of the MOD reproductions were cast at the same time, being attached to the same sprue, and all had precisely the same treatment and conditions except the elastic content of the wax. These patterns, when in the wax and attached to the sprue before investing in the warm investment, were uniform in size and shape, so much so that they could not be discerned one from another. It is particularly interesting to note that Nos. 1 and 2 had the wax put into the cavity by one technic, except that in No. 2 the elasticity was released, and Nos. 3 and 4 by another technic, except that No. 3 had the elasticity released. As you will readily see No. 1 opened and No. 4 closed so much that they would not fit the form at all, while Nos. 2 and 3 fit very correctly. Before stating the difference in the technic of these two bars we should review the physical conditions obtaining in the compound MOD cavity. When a restoration is being made, for a simple occlusal cavity with all walls present, we have only to adapt to inside dimensions and if our inlay is prepared with bevel margins, the fact that it has contracted does not prevent it going to place but simply gives it cavity surface freedom and allows it to settle in a little farther, unless it rides on the pulpal floor, which surface of the inlay can easily be ground. The fact that the gold has contracted makes the inlay enter the cavity more easily than if it had not. If, however, we must restore outside dimensions, only as for example a band surrounding a root or porcelain tooth, the same contraction prevents the gold from going to place by drawing it toward the wall at every point instead of away from it as in the former case. This would be relieved by an expansion and the surface freedom would be in proportion to that expansion. If our restoration is for conditions having both inside and outside dimensions, we immediately meet a new set of restrictions, for while an excess of contraction of our gold will give us cavity freedom on the inside dimensions, it brings embarrassment to the outside dimensions and an excess of expansion, while producing the desired freedom on the outside dimensions will embarrass the inside dimensions. We are required, therefore, in this case of restoration, to work with relative exactness or to introduce a technic that will increase our surface freedom on all surfaces. This can be accomplished by moving the pattern back and forth, in the cavity, thereby planing off as it were all surfaces and producing a free space on all surfaces. This can also be accomplished by compelling the wax to have an excessive shrinkage away from all margins which follow inside dimensions and secure the required freedom for outside dimensions by the expansion of the mass. A suitable technic for this will be described later.

Returning to the description of Figure No. 5 the wax material of the pattern, for both one and two, was introduced by taking a bar of the wax, after it had been kneaded with the fingers, and bending it like a horseshoe at its low working range and in this way placing it in the cavity. The contained elastic strain tended to

make the heals open outward when it was placed in the warm investment, which occurred in No. 1. No. 2 was treated in precisely the same way except that before it was removed from the cavity it had its elasticity released by placing a warm instrument, warm enough to melt the wax, into the mass of wax extended to what would be the gingival floor of the cavity, which released its elasticity. This is also accomplished by flooding the tooth or form with hot water after the wax has been inserted, which accomplished the double purpose, namely, of releasing the elasticity and by an excessive expansion makes some of the wax bulge out of the cavity, which should be scraped off instead of being pressed in after the temperature is reduced. Nos. 3 and 4, Figure 4, had the wax inserted by moulding it into a ball and while at its low working range pressing the ball into the occlusal surface and into the mesial and distal chambers, which introduced into the wax an elastic strain, which tended to make the heals draw toward each other when all four were placed together in the warm investment. This is shown in No. 4. No 3 had identically the same treatment except that before the removal from the cavity its elasticity was released. Nos. 2 and 3, Figure 4, had, therefore, their elastic strain in opposite directions, as expressed in Nos. 1 and 4, but both are of closely the same size after casting and therefore their elastic strain must have been released. The contraction and distortion errors we are here studying become most embarrassing when we are making very complicated restorations, such as the casting of a crown base when it involves outside dimensions or MOD inlays, involving both inside and outside dimensions. It is probable, however, that few of the profession have appreciated how universally this embarrassment enters into our work. This has been most forcibly demonstrated in the past two years by the results of a series of tests made by different members of the profession, partly because of a premium that was offered by the writer of $150.00, which was placed in the hands of the Program Committee of the Cleveland Dental Society, to be given as three prizes for the first three members who would produce a cast restoration which would go to place within one-fiftieth of an inch. The judges were to consist of a committee of five, four of whom were to be dentists and one a Professor of Physics, which committee has done its work very patiently and efficiently. The form that was first provided consisted of a taper column one-fourth inch in diameter. The taper of the sides was to be one per cent per inch with respect to a common perpendicular. This form was expected to reproduce, approximately, the conditions that obtained when casting a gold base for a molar porcelain crown, where the gold extended over the bevel of the porcelain, as well as over a bevel on the roots, but where these bevels were one per cent to a common perpendicular. This condition provides for the reproducing of both an inside and outside dimension at the same time. As stated, the outside dimension, represented by the periphery of the root and the base of the porcelain, was represented by the taper column, the inside dimensions being the pulp chamber and post hole in the porcelain, were represented by surfaces on the inside of a ring. See Figure No. 5. A number of restorations were made for this form from different parts of the country. The conditions for securing the premiums required that the ring go to place over the outside dimensions and in the inside dimensions of this form to within one-fiftieth of an inch of its position when the pattern was made, for in making the pattern the taper column was drawn through it. This would be equivalent to the porcelain tooth going to place in its cast base when placed in the mouth so that the tooth of the opposite jaw, which had been in a normal occlusion at

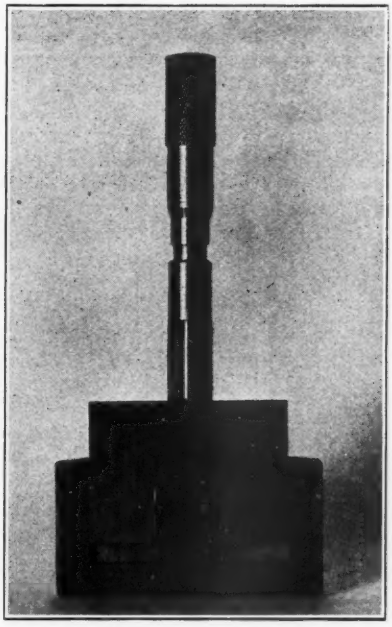
the time the impression was taken, would be not more than one-fifth of an inch from being in occlusion again. A brass plate represented the porcelain tooth in this form. The nearest that any of the restorations came to going to place on this form was one-half inch instead of one-fiftieth of an inch, because of the contraction around this taper column. Objection was made to this form, many dentists stating that they did not cast crown bases but that they could cast MOD fillings with accuracy. Others

Figure 5



stated that they could cast half a ring, even if they could not cast a whole ring, that it was the hole that made the trouble. The explanations for the failures were varied and interesting. Accordingly, the form in which the tests would be made was changed to represent the conditions of an MOD filling, but unfortunately the mechanic got his dimensions large. The wax was put in from the side instead of the end of what would represent the mesial and distal chambers of the cavity. This form is shown in Figure No. 6. The surfaces representing the pulpal walls had a bevel to a common perpendicular of one per cent. The restorations made in this form did not go to place much better than those made for the previous form. Objection was made to this form on the ground that it was abnormally large and that the wax was put in from the side instead of the end. Accordingly, the third form was made, which reproduced, in a very hard steel, as nearly as possible, the actual condition obtaining in the molar tooth one-fourth inch in diameter with an MOD

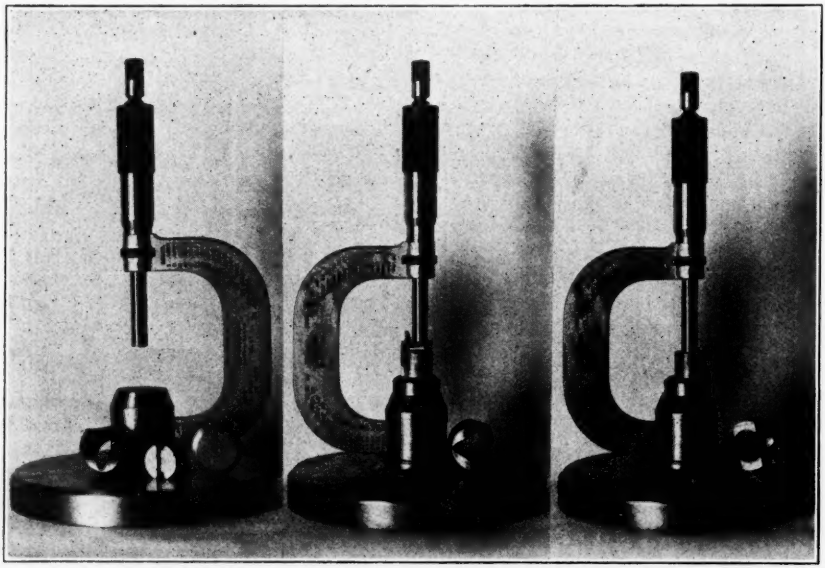
Figure 6



cavity, all walls of which had a taper of one per cent to a common perpendicular. This instrument is shown in Figure No. 7. It is interesting to note that no restorations were made in this form, under the conditions prescribed by the committee, which went nearly to place. The prime condition to secure the premiums required that the restoration go to place within one-fiftieth of an inch, under a pressure not exceeding five pounds. No restorations made in the test went even half way to place and many would not enter

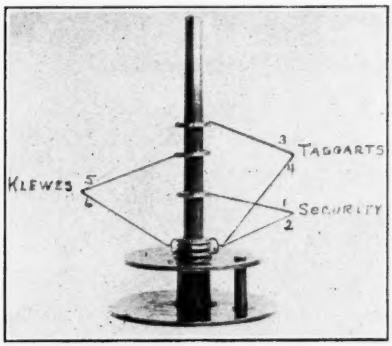
the cavity. Had the contestants used the information that is contained in Figure No. 2, they probably could easily have secured the premiums, for many restorations have been made by following these directions, which were within the requirements. Figure No. 8 shows two rings made with each of three waxes shown on this list, namely, The Cleveland Dental, Klewe and Taggart. With each wax an effort was made to make two rings, one of which would be large and the other small, the latter produced by adding the error of the wax to the error of the gold, and the other, which was large, by subtracting the error of the wax from that of the gold. In other words by introducing a correction. The three rings, Nos. 2, 4 and 6, shown on the bottom of the column in Figure No. 8 are all so large that they will pass readily over the base of the taper column, while the duplicate of each. Nos. 1, 3, 5, stop high on the column, as shown. A large number of restorations have been made in the MOD form, which are so loose that they will rattle. The procedure is as follows: When we make an MOD pattern, and chill it in the cavity, the wax contracts and by being held takes on a condition of elastic strain. If this pattern is removed from the form or tooth, after being chilled, and we undertake to introduce an expansion sufficient to overcome the contraction of the gold, the warming of the pattern releases this elasticity, producing a distortion. If, however, we will remove this wax while it is warm and place it in cold water, producing its contraction without strain, it does not take on an elastic stress. It would, however, be too small to go back into position in the form or tooth. If, now, we will break it across the occlusal and while keeping it chilled replace it in the form or tooth, we will have quite

Figure 7



a wide crack between the broken surfaces. We will now take a wedge of new wax and force it into this opening, after softening the edges with a warm instrument. This will introduce enough new wax in that particular part which has to do with our outside dimensions, so that when the pattern is removed and invested in a warm investment, which temperature is dependent upon the formula of the pattern material, we will produce sufficient expansion of the mass of wax so that it will readily go over the outside dimensions. Care should be taken, however, to release the elasticity of the wax, as previously described, namely, by either flooding the tooth with hot water, prior to fracturing it across the occlusal surface, or by using a hot instrument, passing well up to the cervical floor of the cavity. Another method that answers well, instead of breaking the MOD pattern, is to cut it across the occlusal surface with a sharp knife in one or two places before chilling in the tooth, thereby allowing the contraction to express itself at the point of separation, and after producing the contraction insert additional wax as before. Rings can be made by this same method, which will introduce an expansion correction in the wax more than sufficient to compensate for the fixed contraction of the gold.

Figure 8



Inasmuch as ordinary dental MOD cavities are not prepared with walls so near parallel as one per cent to a common perpendicular, their wider bevel allows them to go more nearly to perfect seating before binding and a less exacting technic will be sufficient to control the contraction of these cavities, which is as follows: Place the wax in the cavity at any desired temperature and after trimming and carving to form, warm thoroughly through, making it very soft by means of a stream of hot water. This will expand the wax, pushing the excess slightly out of the cavity, which will be recarved while hot. Next, place a threaded molybdenum or tungsten bar or wire into the occlusal mass of the wax and recarve, or cut through the occlusal and chill in the cavity and introduce more wax in the cut. Remove and invest in each case in a warm investment. The coefficient of expansion of molybdenum and tungsten is very much less than the gold, the former, being about one-fourth that of gold at normal temperature, and through the entire range of the melting of gold less than one-fifth.

A series of quantitative studies were made to ascertain the laws governing the elasticity of wax. It was found that the standard inlay waxes have an elastic content ranging, 20, 30, 40 and 50 per cent, according to the treatment of the wax, and also that this elastic content tended to release itself if the wax was held for a sufficient length of time, amounting in some cases to days. Figure No. 9 gives a series of curves, showing the rate of release of elasticity of retained wax bars, due to molecular flow. The continuous lines represent tests with bent bars, the dotted lines compressed bars and the alternate line and dotted line stretched bars. This chart shows that with the various waxes and various treatments, the elastic content, though starting as high as fifty and forty per cent, drops to within ten per cent in twenty-four hours, and is practically

gone in ten days. The numbers on the base line indicate the number of days during which the molecular flow is allowed to take place and during which time the wax was retained in its bent position. It clearly is not possible for us to leave our wax patterns in the tooth for a day, or days, in order that the elastic stress may be released by a molecular flow, but it does answer the question why, when a wax pattern is made in the form and left in the form for days before being removed and then cast, it produces a better fitting inlay than if removed at once, unless the elastic content has been released by a quicker method, as by raising the temperature of the wax to the point at which it speedily releases it while the wax is still in the form or tooth. Figure No. 10 shows graphically the form in which the wax bars were bent and held for measuring their elastic stress. **A** represents the position of the wax bar with its base fastened securely in the angular groove. **B** shows the amount of bend put in the wax while at its low working temperature. **C** represents the amount of return, or elastic content, which takes place if the pressure is withdrawn and the temperature slightly raised, which, with all waxes, is large and with many amounting to forty and fifty per cent of the original bend.

Figure 9

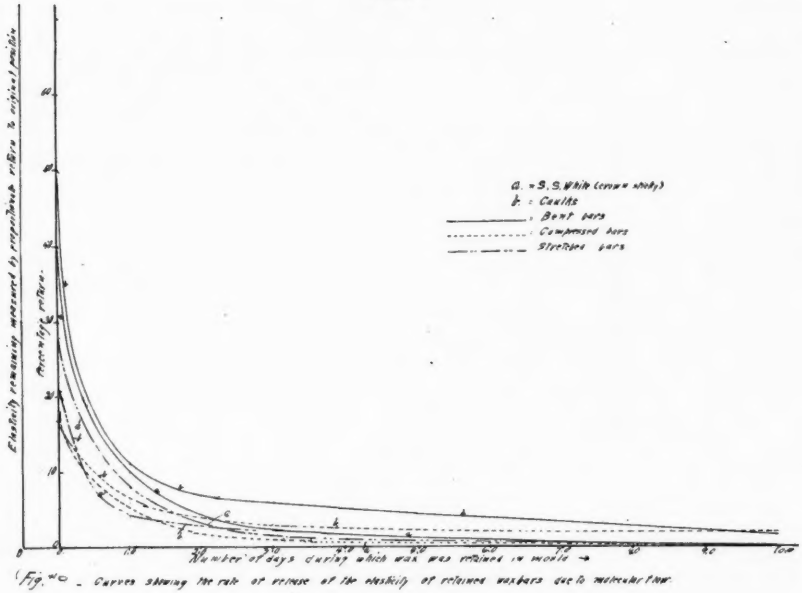
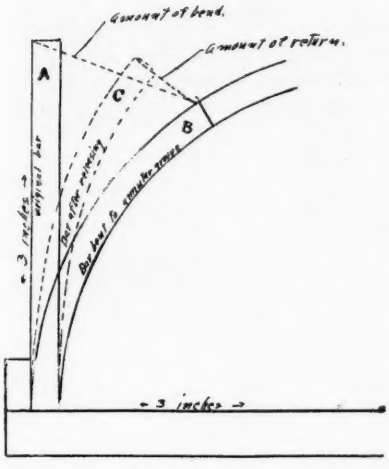

a. = S. S. White (crown wax)
b. = Caulk
Bent bars
Compressed bars
Stretched bars
Elasticity remaining measured by repetitions return to original position
Percentage return
Number of days during which wax was retained in mould →

Fig. 10 - Curves showing the rate of release of the elasticity of retained waxbars due to molecular flow.

The members of our profession will find great benefit and satisfaction in the placing of either staples, or a piece of straight tungsten or molybdenum, threaded or roughened, bars in their complicated patterns, which will control, largely, the warpage of the wax, due to elastic strain, and in a large measure will control the contraction of both the wax and the gold. They will also find it a great advantage to make themselves familiar with means for controling and

Figure 10



releasing the elasticity of the wax and thereby prevent its distressing distortions. We will strongly recommend that you study the coefficient of expansion of the wax you are using, if it is not shown on the chart in Figure No. 2, which contains all the waxes that could be obtained in the open market, make tests to determine its co-efficient of expansion and endeavor to so manipulate it that you will make its dimension change compensate for the fixed contraction of your gold, and this without introducing the errors of the elasticity of the wax. We would recommend that you familiarize yourself with the information shown so graphically in Figure No. 4, which shows the errors and corrections all in one simple casting.

REPORTS OF RESEARCHES IN PROGRESS UNDER THE AUSPICES AND SUPPORT OF THE SCIENTIFIC FOUNDATION AND RESEARCH COMMISSION OF THE NATIONAL DENTAL ASSOCIATION

Organized July, 1913

(Read before National Association at Rochester, N. Y., July 7, 1914.)

Executive Board—Weston A. Price, Chairman, 10406 Euclid Avenue, Cleveland, Ohio; Thomas P. Hinman, Vice Chairman, Fourth National Bank Building, Atlanta, Georgia; Clarence J. Grieves, Secretary-Treasurer, 201 W. Madison Street, Baltimore, Maryland; John V. Conzett, 256 13th Street, Dubuque, Iowa; Eugene R. Warner, 401 California Building, Denver, Colorado.

Members—George T. Williams, Seattle, Washington; *George E. Hunt, Indianapolis, Indiana; W. T. Farrar, Louisville, Kentucky; Percy M. Williams, Rutland, Vermont; Samuel H. McAfee, New Orleans, Louisiana; Edward C. Kirk, Philadelphia, Pennsylvania; William Carr, New York City, New York; Truman W. Brophy, Chicago, Illinois; Greene V. Black, Chicago, Illinois; Homer C, Brown, Columbus, Ohio; Thomas B. Hartzell, Minneapolis, Minnesota; Arthur R. Melendy, Knoxville, Tennessee; Edward S. Gaylord, New Haven, Connecticut; Henry C. Ferris, New York City, New York; Charles Channing Allen, Kansas City, Missouri; Frank O. Hetrick, Ottawa, Kansas; Marcus L. Ward, Ann Arbor, Michigan; Frank L. Platt, San Francisco, California; Chris. S. Van Horn, Bloomsburg, Pennsylvania; Roscoe H. Volland, Iowa City, Iowa.

Ex-Officio Members—Donald M. Gallie, President National Dental Association, Chicago, Illinois; Otto U. King, Secretary National Dental Association, Huntington, Indiana.

*Deceased.

In addition to the researches herewith reported, the Commission has assisted, during the past year, the researches being conducted by Dr. G. V. Black, of Chicago,, Illinois, on "Studies of the Peri-Dental Membrane and of Salivary Calculus" and Dr. Frederick B. Noyes, of Chicago, Illinois, on "The Dental Pulp and Peri-Dental Tissue." Their results will be reported in due time.

The Commission hereby disclaims any and all responsibility for the statements made in this issue or that shall, at any time, be made or published by the research workers, whether technicians or directors, whom the Commission is endeavoring to assist. The authors themselves are individually responsible for their statements.

No money has been paid by the Commission to any of the Directors of these researches for their time or efforts, the assistance given them has been in the form of supplies and a fund for providing technicians to assist in the detail work. The entire cost of the researches of the past year do not reach $4500.00, which is approximately equivalent to an expense of twelve cents for each member of the dental profession practicing in the United States. It is confidently expected that with the increasing support of the profession the work can be very largely increased this next year, both by continuing and enlarging the present researches and by supporting and establishing some new ones. The budget as planned by the Commis-

sion for this year amounts to nearly $8,000.00.

In addition to continuing and enlarging the researches of the past year, the Commission is arranging to assist some additional studies, including Dr. Marcus L. Ward, Ann Arbor, Michigan, on "Cements," and Dr. Wm. J. Gies, New York City, on "The Relation of the Ductless Glands to Definite Dental Problems."

The receipts and disbursements to date are briefly itemized as follows:

Amount of subscriptions, due annually for five years, July 8, 1913	$ 2500.00
Or for five years	12500.00
Amount of subscriptions, due annually for five years, on July 6, 1914, including the former, are	8179.50
Or for five years	40897.50
Total cash collected to July 6, 1914	7067.50
Total disbursements to the close of the National meeting, July, 1914	4378.06
Balance in the Treasury	2689.44

Itemized Disbursements.

To Technicians to July 1, 1914:	
Mr. Fahrenwald, assisting Dr. Price	$ 1100.00
Mr. Rickert, assisting Dr. Bunting	500.00
Dr. Leonard, assisting Dr. Hartzell	343.75
Mr. Gaskill, assisting Dr. Hartzell	376.32
Dr. Henrici, assisting Dr. Hartzell	300.00
Dr. Potts, assisting Dr. Black	300.00
Dr. Larsen, assisting Dr. Hartzell	100.00
	$ 3020.07
For laboratory equipment for Dr. Hartzell	$ 368.50
For laboratory expenses for Dr. Noyes	100.00
For Metallurgical Laboratory expenses	186.25
Traveling expenses to December, 1913, meeting of the Board at Toledo, Drs. Warner and Hinman	129.25
Bond for Dr. Grieves	7.50
Postage, Printing, Stationery, Stenographer, (including all office expenses) from January 1, 1914, to July 1, 1914	565.89

The expenses, including printing, postage, stationery, clerical work, etc.; incidental to the organization and development of this department from September, 1912, to January 1, 1914, amounting to $1073.39, were contributed by the Chairman. The Executive Board and Commission refused to permit this and ordered that it be carried as an expense bill with interest at six per cent. The Chairman thereupon contributed this amount to the Endowment Fund, which fund, it is expected, will, ultimately, become large enough to enlarge and carry on the work perpetually.

THE EXECUTIVE BOARD.

TRANSACTIONS

OF THE

EIGHTEENTH ANNUAL MEETING OF THE NATIONAL DENTAL ASSOCIATION

Held at Rochester, N. Y., July 7-10, 1914

FIRST GENERAL SESSION

The first general session of the Eighteenth Annual Meeting of the National Dental Association was called to order at 11 o'clock Tuesday morning, July 7th in Assembly Hall, Exposition Park, Rochester, N. Y., by the President, Dr. Homer C. Brown, of Columbus, Ohio.

The President introduced the Rev. C. Waldo Cherry, of Rochester, who invoked the Divine blessing upon the deliberations of the Association.

THE PRESIDENT: Gov. Martin H. Glynn had expected to be present to welcome us in behalf of this great State, but in his absence he has delegated Dr. Downing to act for him on this occasion. I take pleasure in introducing to you Dr. Augustus S. Downing, Assistant Commissioner for Higher Education of the State of New York. (Applause).

Address of Welcome.

Mr. President, Ladies and Gentlemen:

It is a very unexpected but distinguished honor that comes to be my lot this morning, to present the sincere regrets of His Excellency, the Governor of this State, that he is, because of his official duties, unable to be present with you. In lieu of his presence, he has sent to you his greeting and welcome in the form of a letter which I have the honor now to read.

To the President and Members of the National Dental Association, Assembled in Rochester:

Ladies and Gentlemen:

I appreciate the invitation to meet the members of this conference, and regret that my engagements do not permit me to be present. This is perhaps the first time that my regret at foregoing a visit with members of your profession has been entirely sincere, for all other invitations have been from doctors of dentistry in their official capacity, and for professional purposes.

The reluctance with which the average man approaches the dentist's chair is in a way a measure of the usefulness of such gatherings as this. The more man dreads the operations which are necessary for his health and comfort, the greater is the need for co-operation which will make these operations easier and more comfortable. There is counsel as well as safety in numbers, and the foregathering of members of the dental profession from all over the country indicates that they are seeking an exchange of ideas which is the surest guarantee of progress, and, far from being indifferent to your deliberations, men from other walks of life are interested in the progress of your profession. This country should take an especial pride in the profession which you represent, for, just as we are apt to look abroad for leadership in medicine and surgery, the rest of the world looks to America for leadership in the field of dentistry.

I bespeak for you a pleasant and successful conference, and extend to our visitors from other commonwealths a cordial greeting on behalf of this State.

Yours sincerely,

MARTIN H. GLYNN.

(Applause.)

Ladies and Gentlemen:

It is no small nor insignificant distinction which you pay to this State by gathering in this, your Eighteenth Annual Convention. You come together as men and women, not as practitioners of dentistry only, but as men and women interested and concerned for the betterment of civic conditions. You come to discuss not only practical ways and means of following your profession, but also to study those questions which concern the conservation of public health and life. Within the last five years there has come to be a closer relationship and a better understanding between medicine and dentistry. This is evidenced in the presence this morning of the President of the American Medical Association, who will deliver one of the principal addresses. You are welcome to this great State of ours , for although my native state, Maryland, has the honor of having established the first dental college in this country, in 1839, the honor goes to the Empire State after all, for in 1868 it put upon the statute books the first law to regulate and control the profession of dentistry. And through all these years this State has been the leader in devising means and ways for progress in the dental profession and dental education. This State believes in control of the profession, not only dentistry, but medicine and law and pharmacy and optometry and, even so simple a profession, as it would seem to you, of chiropody.

It falls to the lot of the State Educational Department, whose immediate representative I am, to have the direction of all these affairs relating to the professions. These conferences which you will hold here will be an aid to us. We must look to the men from California and Maine and Tennessee, and all parts of this country, assembled as you are, not only to confer in regard to your own profession, but to give counsel and advice to us who are working with you toward the betterment of conditions.

This is a glorious State. You come here to her most beautiful city. I say that without disparagement to her sister city on the borders of Lake Erie or the great Metropolis in the southeastern part of the State. It is the most beautiful city in all the great United States, barring the one from which you come in your own mind. The Mayor and the Secretary of the Chamber of Commerce will tell you about that. (Laughter).

As you go through this great State, you will find there is no greater or more beautiful river in all the world than the Hudson, with all its scenery, with all its evidence of the growth of civilization. When you talk of mountains, of health-giving resorts, the Adirondacks are open to you. To all the joys and pleasures of this great State, we bid you welcome. If it is wealth that you want to observe, you will go to New York City, where it and the rest of the State has paid just one-half of the whole income tax of the country. That is only typical of the greatness of this State, and its greatness is only typical of the warmth of the welcome that we give to you who come here from all over this country.

You are working not only for the money that is in your profession, although that is absolutely necessary, but there is a far higher aim in this Association, and that is the preservation and conservation of public health and public life. Your work is not alone for your own immediate locality, but it is for the whole country, and not only for the country, but for the world, because this country leads all other countries in the world in its progress in the profession of dentistry. They look to us for ideals, and you make the ideals. The work that you do is sometimes wearisome, just a pure labor of love, but, as has been well said, the work is your religion and your religion is in your work, and one of these

days the president of this association and his associates and the rank and file that have given their life's blood for the benefit of the generations to come, will lay down the burden and nobody has put it for consolation in better words than that distinguished poet, Kipling:

And when the last picture is painted,
And the tubes are all twisted and dry,
And the oldest color has faded,
And the youngest critic has died,
We shall rest, and faith we shall need it,
Lie down for an aeon or two,
Until the Master of all good workmen
Sets us some new work to do.
And only the Master shall praise us,
And only the Master shall blame,
And no one shall work for money
And no one shall work for fame,
But each for the joy of the working,
Each in his separate star,
Shall draw the thing as he sees it,
For the God of all things as they are.

In behalf of the Governor of the State and all its citizens, I bid you, ladies and gentlemen, a most cordial welcome.

Welcome from the City of Rochester.

The president next introduced Hon. Hiram H. Edgerton, Mayor of the City of Rochester, who extends words of welcome on behalf of the city. (Applause).

Mr. President, Ladies and Gentlemen:

This morning at the breakfast table I told my daughter who was visiting me of this Convention, and of my appearing here today, and she said: "Tell them the story which I heard yesterday." It was of a young man who wanted to join the army, and go to the front and fight the Mexicans if it was necessary. He passed a splendid physical examination until they got to his teeth. They were found defective, and he was rejected. He was very much disappointed, and expressed his disappointment by saying "Have I got to eat them after I shoot them." (Laughter). If I could find that young man, I would bring him over to your free dental dispensary today and have him fixed up so they could make a good soldier out of him. I think you could do it in a very short time.

The last speaker said it was an unusual and distinguished honor to appear before you. It is a very distinguished honor for me to appear before you, but not an unusual one. It is unusual to appear before this particular convention, but Rochester in the past few years has become a great convention city, and it has been my privilege to extend the welcome of our city to many conventions consisting of all sorts of people, professional, business, fraternal, labor, religious and others. It is only a very few years since Rochester has been able to take care of a convention of this kind. Three years ago this beautiful park in which you now are was an abandoned juvenile prison, surrounded by a wall of stone twenty feet high. During that time this wall has been removed, these buildings renovated, some torn down and carted away, and it has been made, I believe, one of the best places for an exhibition and convention of your kind or any kind that can be found in this country. We have organized and started here an exposition, which is held every autumn, occupying all of these grounds, which has rivaled any other exposition of that kind held in this country in its three years of existence. And we expect this fall that it will outdo almost everything in that line. We invite you all to come to it.

We are very proud of Rochester. It is a city of homes, of happy and contented people, of parks and playgrounds, of splendid schools, of well paved and clean streets, well organized in every respect. We trust that you will not spend all of your time out here at this convention, but that you will take the opportunity of looking about our City, so that when you go away you will be convinced of the truth of what the last speaker has said as to its being the most beautiful city in all the land. Our parks are famous throughout this country, and the devel-

opment in recent years has been wonderful and remarkable. I am not going to make any extended speech; I am going to leave that to the silver-tongued orator from the Chamber of Commerce. He can talk to you by the hour, and he knows how to tell it much better than I do.

For my part, on behalf of the City I extend to you again a most hearty greeting, and, so far as it is possible for me to do so, I extend to you the freedom of our City. Go where you will, I feel sure you will be welcomed. I trust that your deliberations here will be such as to be of great benefit to your organization, and that you will go away with such pleasant memories of Rochester that you will want to come back again as soon as you can. (Applause).

THE PRESIDENT: I now present Mr. Roland B. Woodward, Secretary of the Chamber of Commerce of this City, who will speak in behalf of his organization.

Welcome from Chamber of Commerce.

Mr. President, and Ladies and Gentlemen:

I am really getting a little sensitive about these allusions to the length of my speeches, because so many men have approached me the last two or three weeks wondering whether I was going to talk thirty seconds or thirty minutes. And I am reminded of a young girl who got on the street car in Boston, and she had her hand carelessly in one end of her muff. An enterprising young man got in and sat down beside her. Seeing the opening, he thought he would take advantage of it, so he stuck his hand in the other end of the muff, and after he had grasped her hand firmly, she turned to him and said, "Now, young man, if I were not a Boston girl with poise and self-control, I would yell out and get you into trouble, but I will give you just ten minutes to take your hand out of there." (Laughter). If I meet a condition like that, I want at least ten minutes. But I need not tell you that you are welcome to Rochester. There is a welcome in the air which you breathe. There is a welcome in the appearance of the City. There is a welcome upon the faces of the people, and surely in their hearts, for you. And I think it is singularly happy, Mr. President, that this convention of idealists should come to a city of ideals. I know of no profession that is so interested in extending the service of its skill and its scientific knowledge than that of the dental profession, and I am very proud of the part that Rochester has played, through its free dental clinics, to help the children of Rochester to better health, to greater happiness, and to increased efficiency. Of course we are also proud of our great manufacturing institutions, fifteen or sixteen hundred of them, and we are proud of our great mercantile establishments, and we are proud of the deposits in our savings banks, those evidences of the thrift and frugality of our citizens, and we are proud of all our physical assets that indicate work laid up in store for the service of our citizens. However, in that respect Rochester differs very little from many cities in this land, and many of you have come from great centers of prosperity, wealth and power. But we are proud of Rochester for an entirely different reason than that. We are proud of the spirit of the city. We take pride in our parks, our play grounds, and our breathing spaces. We take pride in the fact that so many of our workmen own their own homes. We take pride in our schools and churches, and in that greatest product of the city, its children. So, no matter where you come from, whether you have come from the East with its culture and refinement, or whether you have come from the far Pacific Coast, where optimism is breathed in the air, just as the fragrance of its roses, or whether you have come from the broad prairies of the West, that typify the great and powerful sphere of

democracy, or whether you have come from that great and glorious and hospitable land of the South, you have come to a city that unites them all in its spirit of welcome to you. Our hearts are yours, our homes are yours, our parks, and everything that we have, to enjoy while you are here, and I can only say further that Rochester extends to you this morning her most distinguished consideration. (Applause).

THE PRESIDENT: My view of part of this audience has been obstructed by these beautiful flowers, and, being of an inquisitive nature, I wonder where they came from. I finally saw the corner of a card, on which I read, "Compliments of the Columbus Dental Society, Columbus, Ohio." (Applause).

"There's part of the sun in an apple,
There's part of the moon in a rose;
There's a part of the flaming Pleiades
In every leaf that grows.

"Out of the vast comes nearness,
For the God Whose love we sing
Lends a little of His Heaven
To every living thing."

Responses to the Addresses of Welcome.

The president then introduced Dr. B. Holly Smith, of Baltimore, who responded to the very cordial addresses of welcome, as follows:

Mr. President, Mr. Mayor, Mr. Secretary of the Chamber of Commerce, the Representative of the Governor, Ladies and Gentlemen:

I thought while the gentleman was speaking what a fine thing it was to be the governor of a State, or the mayor of a city, and especially such a mayor of such a beautiful city as Rochester, and then it occurred to me, what would you do if you were mayor or if you were governor? I know some of you fellows down there, like Barber and some of the other boys, who think they know me pretty well, would say, "If Holly Smith were mayor, the first thing he would do would be to write out a bundle of pardons, franchises and excuses, and then he would go out and smash some of the things that he didn't like. But you are wrong. I wouldn't do it. I am tolerably fond of a smash, but destructive executive action is never as beneficial to the people as constructive action. What I really would do, if I were governor or mayor, would be to establish a dental clinic in every public school in my state or city, so that there would be no more crying of the children by night. Gee, wouldn't that be bully? (Laughter and applause). But I am neither governor nor mayor, and it seems to me the only consolation I can get out of this job is to talk back to the Governor and the Mayor and the Secretary of the Chamber of Commerce.

I am chartered to run at least five minutes, and I do not believe, on such an occasion as this especially, I should abrogate your charter rights. I heard a story of an Irishman in New York who was trying to persuade one of his fellow countrymen not to go West, but to stay in this State, and he used it as the climax of his argument. "Why, Pat, me boy," he says, "this is a great state. Sure they don't even hang a man for murder in this state." Pat says, "What do they do with thim, then?" And Mike says "Why, they just kill thim by elocution." And I should imagine that is a very pleasant way for an Irishman to die, especially when the elocution is so imbued with cordial greetings and terms of hospitality. It is indeed a great pleasure to come into this Empire State with your great financial enterprises, your vast commercial affairs, your numberless factories and grand opportunities for education. We come here from all parts of this country, for the purpose of accomplishing something for the benefit of the people and our profession. We come not asking alms or begging favors, but we come bearing tribute from the skill, ingenuity, the knowledge, the liter-

ature, the methods of practice of our and allied professions the world over. We come preaching the doctrine of physical righteousness, to tell you how, when and why to do things for the relief of pain and disease. We come to fraternize. We come to meet those we have long loved. We come to recall the splendid and heroic deeds of those who meet with us no more. We come to meet your people, and to get acquainted with them, and to receive a splendid inspiration from the work that they have done. We come to admire your beautiful city and its environments. It is no small recommendation to Rochester that she is so free with her invitations to conventions, for these invitations involve not only her municipal officers, but her commercial interests, her scientific and professional organizations. We have heard of your splendid teaching along the line of oral hygiene, of your splendid social service campaign. The Rochester Movement, as it is called, has spread from one end of the land to the other. If in coming here we have met with your approval, we are happy and we thank you. (Applause).

THE PRESIDENT: Before proceeding further with the program, I have a brief statement to make. I attended the Annual Meeting of the New York State Dental Society and returning from there I was informed that Dr. Hofheinz and Dr. Jarvie were to sail the following morning for a trip abroad in order to recuperate. In behalf of our Association I prepared a telegram for Dr. Gilbert to send, after securing the name of their steamer, hoping it would reach them before sailing. It did not, but was forwarded. I have this letter from Dr. Hofheinz.

Wanheim, June 17, 1914.

Dr. Homer C. Brown, President of the National Dental Association.

Dear Mr. President and Gentlemen:

Your dispatch in behalf of the National Dental Association wishing myself, wife and Dr. Jarvie a pleasant and beneficial visit abroad, did not reach us on the steamer which left May 16th. It was forwarded in a letter by Dr. Gilbert, of Rochester, and I beg you to accept my sincerest thanks and appreciation.

It will please my old friends to know that my health has improved considerably and that I may again be able to take up some work in the profession which, I have practiced and loved for so many years.

Please accept my best wishes for a successful meeting in our beautiful city.

I take pleasure in enclosing my check for $50.00 to the fund which our National Dental Association has so nobly originated for the aged and needy members of our profession.

Thanking you again for the good wishes, believe me

Most sincerely yours,
RUD H. HOFHEINZ.

The President called the First Vice President, Dr. Charles Channing Allen, to the chair.

THE FIRST VICE PRESIDENT: We will now listen to the address of President Brown. (Applause).

(See the President's address on page 3 in this issue of the Bulletin.)

(President Resumes Chair.)

The next order of business as announced by the President was an oration by Dr. Victor C. Vaughan, President of the American Medical Association, Ann Arbor, Mich. Subject: "The Functions of Dentistry and Medicine in Race Betterment." (See page 14.)

The President then declared the general session adjourned until 8 p. m. Tuesday.

REPORTS OF RESEARCHES OF THE SCIENTIFIC FOUNDATION AND RESEARCH COMMISSION

SECOND GENERAL SESSION, TUESDAY, 8 P. M.

The second general session was called to order Tuesday, July 7th at 8:00 p. m. by the President, Dr. Homer C. Brown.

The President introduced the chairman of the evening and said in part:

In order that some of you may better understand what sacrifices have been necessary in order to bring about the results which have been accomplished by the Scientific Foundation and Research Commission, it may be interesting for you to know that in perfecting this organization to its present standard the chairman of this commission has attended 36 society meetings and gave 26 distinct stereopticon lectures. He has also given nine clinics in connection with some of these meetings and in this work. In addition to this he has attended eight conferences in different sections of the country. In doing this it was the chairman's intention to stand the personal expenses connected with this organization work, which exceeded one thousand dollars. He expected to contribute this in addition to his subscription, which, I assure you, was not a small one, but his co-workers appreciated what he had done and, against his wish, they would not accept it. However, there was one other course open and he took that. In doing this he accepted a refund of his personal expenses that he had incurred and then had the pleasure of making the first $1,000.00 contribution to the endowment fund (Applause).

I have been in close touch with the work that this commission has been doing, as well as the sacrifices that the various members of the commission have been called upon to make, and it is justly due these men that the profession give them the same co-operation, and additional, if possible, that they have been giving them the past eighteen months.

I take pleasure in presenting Dr. Weston A. Price, Chairman of the Research Commission, who will now take charge of the program for the evening (Applause).

DR. PRICE: Before starting our program, the chairman of the Clinical Committee, Dr. Conzett, has an announcement to make.

Thereupon, Dr. Conzett announced the plan for participation in the progressive clinic.

The President announced that the Panama-Pacific Congress will be held in San Francisco next year, that the chairman and secretary of that organization are attending this meeting and they have requested that the executive committees from the various states meet with them at one o'clock Thursday in the hall to the rear, and that Dr. Platt has some slides of views in connection with this exposition and that he would like to present them to this association and it has been arranged to do this Thursday evening following the scheduled program.

Ladies and Gentlemen:

I have a very particular pleasure in presenting now as the first speaker of the evening Dr. Thomas B. Hartzell, of Minneapolis, Minn., who will address you, reporting in a very brief way the important researches that he has been making for the commission and for you

on the relation of mouth infections to certain systematic infections. Dr. Hartzell will now address you.

Ladies and Gentlemen:

I would like to state in the beginning that we are not in a position to make deductions from any of the material presented here that are positive. Anything that I may show you will be a simple statement of fact of what has happened under certain conditions and I do not want in any way to compromise myself by stating as positively so anything that I am thus far reporting. I realize thoroughly that this work should be carried on for a period of at least five years before we would be justified in drawing definite conclusions to which you may pin your faith. However, the work is strongly suggestive of certain facts, of certain conditions, and you are at liberty to draw your own conclusions and to accord these facts such weight as you may see fit. I say this in justice to myself and to the research corps who have been at work on this problem.

(Dr. Hartzell then read his paper. See page 48.)

DR. PRICE: I hope it is clear to every one that none of your money has gone to Dr. Hartzell, personally, because is has been a rule of the commission that money has only been expended to furnish technicians, who would be eyes and ears to enlarge the capacity of certain men who had become so engrossed in problems and so earnest that they should be solved that they were already sacrificing themselves, and Dr. Hartzell was one of them, and I am sure that by your recognition you approve of our selection of Dr. Hartzell as one of the men who might use the money you have contributed to engage technicians to enlarge his output. (Applause).

DR. HARTZELL: I just want to take one minute of your time to say that my associates in this work have been Dr. Harold J. Leonard, hospital research worker, and Dr. A. J. Henrici, who has been a most earnest and enthusiastic worker, and who will be one of the foremost pathologists of this country if he lives.

DR. PRICE: The next series of studies will be presented by Dr. Russell W. Bunting, who has made investigations along the line of "Studies on Salivary Analysis." (Applause).

(Dr. Bunting's paper will be found on page 16.)

DR. PRICE: I wish, gentlemen, that you might be able to see the splendid volume Dr. Bunting has placed in my hands as including the splendid report of that work. The very nature in which it is compiled and illustrated demonstrates the thoroughness with which he has done that work.

Dr. G. V. Black, the veteran of all the living dental research men, could not be with us at this time, but he has sent the message that he is making progress and he does not wish to make a report yet. They are working on the problem of the salivary calculus and the studies of the peridental membrane.

Dr. Frederick B. Noyes was called unexpectedly and suddenly to Italy on account of the severe illness of a very dear friend. I got a telegram today in which he sent greetings to the commission and to the association and said that he would make his report on his return for publication and to announce progress at this time. Dr. Moorehead, who has been associated with Dr. Noyes in that work, will tell us briefly of the work they are contemplating. Dr. Moorehead. (Applause).

Mr. President, Ladies and Gentlemen:

I just want to make one simple statment and that statement is this: that the work in which Dr. Noyes is engaged is the study of the injury and repair of peridental membrane. We have conducted a series of experiments in which

we have used some fifty or sixty dogs. That is all the statement to be made at this time. In perhaps a year Dr. Noyes will have a statement to make about the peridental membrane, its vitality and its power of regeneration that we think will be of tremendous worth to the dental profession, and I can assure you that he will be busy upon his return from Europe and when he makes a report you can depend upon it as being worth a great deal.

The next order of business was the report of the National Research Commission, by Weston A. Price, Chairman.

(See page 71.)

Dr. Henry W. Gillett, of New York City, was then introduced and made a statement of the work and an appeal to the members of the dental profession present and especially the New York State members to subscribe funds for the support of the work of the research commission.

Thereupon the session was declared adjourned.

PROCEEDINGS OF THE HOUSE OF DELEGATES OF THE NATIONAL DENTAL ASSOCIATION HELD AT ROCHESTER, NEW YORK, JULY 7-10, 1914

First Meeting—Monday, 10:30 A. M., July 6

THE House of Delegates held its first session in the Powers Hotel, and was called to order by the president, Dr. Homer C. Brown, of Columbus, Ohio, at 10:30 a. m.

First in order was the roll call of the one hundred delegates that had been regularly enrolled and were entitled to seats in the House of Delegates.

The president then announced that the House of Delegates was ready to take up matters of business.

DR. H. J. BURKHART: In view of the fact that the Membership Committee of the Sixth International Dental Congress has discriminated against Americans practicing dentistry in the British Isles, and has refused to permit them to become members of that Congress, I believe we should adopt the following resolution: "Resolved that the President of this Association be directed to send a cablegram to the President of the Sixth International Dental Congress, to the effect that the National Dental Association learns with regret that American dentists practicing in the British Isles are not admitted to membership in that Congress, and that the National Dental Association expresses the hope that the rules will be changed so that American dentists practicing there may be admitted to full membership."

On motion of DR. B. HOLLY SMITH, of Baltimore, Maryland, which was duly seconded by Dr. W. E. Boardman, of Boston, Massachusetts, this resolution was adopted by a unanimous vote.

The unanimous consent was then given to the president to appoint a committee of three to draft the cablegram.

The President appointed Drs. H. J. Burkhart, B. Holly Smith and Waldo E. Boardman.

THE PRESIDENT: I have taken up with the state department at Washington the matter of our government accepting the invitation extended by the King to participate in the Sixth International

Dental Congress and the appointment of government delegates thereto.

However, it is necessary for Congress to authorize the acceptance of such invitation and the appointments of such delegates.

A bill was introduced, passed the Senate approved by the Foreign Relations Committee of the House, and is now before the House or subject to call. I have written letters to Speaker Clark, Senator Pomerene and Congressman Brumbaugh urging them, on behalf of the organized dental profession of the United States, to try to have this bill made a special order. It has been suggested it might be appropriate to send a message to the Speaker of the House in behalf of the National Dental Association requesting that S. J. Resolution 105 be passed.

DR. HERBERT L. WHEELER, of New York City, moved the adoption of a resolution urging the House of Representatives, the Speaker of the House, the Chairman of the Committee on Foreign Relations, Chairman of the Rules Committee, Congressmen Danford and Dunne of this district to pass the S. J. Resolution, No. 105 immediately, if possible.

This resolution was seconded by Dr. W. A. Giffen, of Detroit, Mich., and adopted by a unanimous vote.

THE PRESIDENT then announced that as all the states were not represented he would not appoint the reference committee until the next meeting of the House of Delegates.

DR. ARTHUR D. BLACK, of Chicago, then presented several proposed amendments to the Constitution and By-Laws. These Amendments were received and referred to the Committee on Amendments.

On motion of DR. BLACK, the Committee on Amendments were instructed to present a suggested grouping of states in accordance with the present membership for consideration in connection with the action taken on that proposed change. This motion was seconded by Dr. H. Clay Hassell and carried.

THE PRESIDENT: The Secretary has advised me that he has received $11,883, which means 11,883 members (Applause). In addition to this we are advised that Southern California will come in at this time with 400 more (Applause). Then there are a few states that have not yet met for their 1913-1914 meeting.

DR. BOTE: I just want to say that out of 65 naval dental surgeons, 54 have joined the Association. The others are in the Island Possessions, and as soon as we can get in touch with them they will all join (Applause).

THE PRESIDENT: We are just informed by the California delegation that before we are through California will have 1,000 members for us (Applause).

DR. BLACK: I move we recess at this time until tomorrow afternoon at three o'clock at Exposition Park.

(Motion seconded by Dr. Finley, and carried).

(Continued in next issue.)

REPORT OF COMMITTEE ON PRESIDENT'S ADDRESS

July 8th, 1914.

To the Officers and Members of the House of Delegates of the National Dental Association:

Your Committee on the President's Address beg leave to report as follows:

President's Address.

Your Committee wishes to commend the careful manner in which the president has reviewed the past year's work. It would have afforded the members of

your committee a great deal of pleasure to have commented upon the masterly address of the President and given each subject and paragraph the careful consideration it undoubtedly deserves. But owing to the exceedingly short time allowed your Committee, in which to not only consider this, but also the important reports of several committees we were compelled to consider the recommendations only. But we cannot refrain from giving due mention to, and commending him for the splendid work accomplished in the reorganization of the Association, and his unselfish sacrifice of time and energy in so successfully attaining this purpose.

Approval of Organizations.

Your Committee concurs in the recommendations of the approval of the purposes of the American School Hygiene Association, and the Race Betterment Congress, and the appointment of delegates to these meetings.

Miller Memorial.

Your Committee recommends that this Association send a suitable representation to participate in, and to officially represent the National Dental Association in the ceremonies attending the unveiling of the Memorial Monument erected in honor of the late Dr. Willoughby D. Miller at Columbus, Ohio.

National Dental Journal.

In the opinion of your Committee, this question is one of, if not the most important, that will be presented for the consideration of the House of Delegates at this Session.

It is the unanimous opinion of your Committee that a National Dental Journal should be published by this Association. We do not, however, believe that it is expedient to attempt the publication of a journal in 1915, for the reasons that this Association will not hold its regular Annual Meeting in 1915, having voted to participate in the proceedings of the Panama-Pacific Dental Congress, to be held in San Francisco; also owing to the probability that many of the members may not find it convenient to attend this meeting in San Francisco, we deem it inadvisable to incur the necessary raise in dues, which the publication of the Journal would necessitate. Therefore, your Committee recommends that the Association publish a Journal as early in 1916 as seems advisable.

Your Committee heartily commends the President's recommendation with reference to a Journal Commission, to be selected by the Board of Trustees, subject to the approval of the House of Delegates.

Increasing Dental Educational Standards.

The President's passing reference to the necessity of improved preparatory qualifications of the Dental Matriculate, and more particularly the necessity of a higher standard of qualification for practice, should be given more serious consideration by this Association. Referred to Reference Committee on Dental Education.

Research Commission.

In view of the fact that this commission has not as yet made a report, your Committee begs leave to pass this question for the present.

Legislative Committee.

Your Committee concurs in the action of the President relative to the proceedure in regard to House Bill 6282, and recommends that the House of Delegates follow his suggestion relative to sending a telegram to Senator Pomerene, advising him of the official action of the Association, and his further suggestions relative to the appointment of the legislative, public dental education, and oral hygiene committees are worthy of consideration.

Army Dental Corps.

Your Committee heartily endorses the recommendations of the President with reference to raising the standing of the Army and Navy Dental Corps, and would urge that the Legislative Committee to be elected be instructed to exert their best endeavors to accomplish this purpose.

Committee Questions.

Your Committee heartily approves the recommendations of the President with reference to the section on Committees and would respectfully refer the paragraph on Committee Questions to the Committee on Amendments.

Your Committee approves the suggestion of the President with reference to the combining of the Oral Hygiene and Public Dental Education Committees, and suggests that one Committee be appointed to be known as the Oral and Dental Hygiene and Public Education Committee, and that this Committee take up the question of the preparation of a School Text Book on Dental Hygiene, to report to the House of Delegates next year.

With reference to the suggestion of the President relative to the basis of representation in the House of Delegates in those State or territorial possessions, where more than one Society is recognized, your Committee is in full accord.

President-Elect.

With regard to this section of the President's address your Committee would respectfully refer the proposition to the Committee on Amendments, with the suggestion that provision be made for electing the President-elect in accordance with the recommendation, providing that adequate provision be made for a recall should occasion require.

In the part of the President's address in which he recommends that the restriction in the By-Laws, which makes a Trustee ineligible for the election to the office of a President or Vice-President, or President-elect, if the previous recommendations be adopted, we fully concur and respectfully request that this question be referred to the Committee on Amendments.

Printing of President's Address.

Your Committee is emphatically of the opinion that the President's address should be printed and placed in the hands of the Delegates immediately after reading.

Your Committee approves the President's recommendation that the proceedings of the 1914 meeting of the Southern Branch be published jointly with the proceedings of this Association.

Your Committee approves the recommendation that only members and guests of this society be admitted to its sessions and Clinics.

Your Committee concurs in the recommendations that the first sentence in Section 3, Chapter 4 of the By-Laws be stricken out; also to eliminate the words "Book 1, Book 2, Book 3, Book 4, and Book 5" in By-Laws. Also to eliminate Article 8 of the Constitution referring to Branches, respectfully referring the same to Committee on Amendments.

Law Committee's Report.

The Law Committee's Report was fully considered and thoroughly discussed, and your committee heartily endorses the President's recommendation to continue the Committee, and also concur with the policy contained in the Report of this Committee.

Public Dental Education.

After a careful consideration of the report of this Committee, your Committee believes that they have done valuable work in this field, and feel that it is of such great importance that we recommend that this Committee be continued as a permanent Committee, and, therefore suggest that one Committee be appointed to be known as, The Dental Hygiene, and Public Education Committee, and that this Committee take up the question of the preparation of a School Text Book on Dental Hygiene, to report to the House of Delegates next year, as we have suggested in the report on the President's Address.

Respectfully submitted,

LAFAYETTE L. BARBER,
Chairman.
ARTHUR M. FLOOD,
H. CLAY HASSELL.

CONSTITUTION AND BY-LAWS AND CODE OF ETHICS

OF THE

NATIONAL DENTAL ASSOCIATION

(Revised, as Amended by House of Delegates, at 1914 Session)

CONSTITUTION

ARTICLE I.

Name.

The name of this organization shall be the National Dental Association.

ARTICLE II.

Object.

The object of this Association shall be to promote the art and science of dentistry. To achieve this the Association shall endeavor to unite the dental profession of the United States into one compact body, thus creating a power the units of which, working with a harmony of purpose, will foster fraternal relations and intercourse among dentists; safeguard the material interests of the profession; elevate the standards and improve the methods of dental education; secure the enactment and enforcement of just dental laws, while aiming at a unification of state dental statutes, and enlighten and direct public opinion in relation to oral hygiene, dental prophylaxis and advanced scientific dental service.

ARTICLE III.

Membership.

The membership of this Association shall consist of the present members, and such members of the Constituent Societies, and such members of the Army Dental Corps, and of the Navy Dental Corps, and such others as shall be elected in accordance with the By-Laws, as hereinafter provided.

ARTICLE IV.

Constituent Societies.

Section 1.—State and Territorial Societies which have, or which hereafter may, become organized in conformity with the general plan of the National Dental Association, and which have declared their allegiance to said National Dental Association, and which shall agree to the formation and perpetuation of the House of Delegates, shall be recognized as Constituent Societies, upon a majority vote of the Board of Trustees.

Sec. 2.—The term "State Society" shall be understood to mean the representative dental organization of any one of the States which have been received into the Union, and whose active membership is restricted to legal practitioners practicing within the legal borders of such State. The term "Territorial Society" shall apply in similar manner to the representative dental organization of any of the territorial possessions of the United States. Provided, however, that the term "Territorial Society" shall be held to include the societies of the District of Columbia, of the Canal Zone, and of the insular possessions of the United States.

ARTICLE V.

The House of Delegates.

Section 1.—There shall be a business body known as the House of Delegates of the National Dental Association. It shall consist of delegates elected by the Constituent Societies, and by the other dental bodies named in Section 2 of this article. The House of Delegates shall represent the delegated powers of the members of the National Dental Association, and shall be the national representative body of the Constituent Societies. It shall elect the general officers of the

Association and a board of nine trustees, and shall transact all the business of the Association, public, professional, or scientific, not otherwise provided for. The trustees shall be members of the House of Delegates, without the right to vote.

Sec. 2.—The total voting membership in the House of delegates, exclusive of the Board of Trustees, shall be as follows: One delegate shall be allowed from each Scientific Section, from the Army Dental Corps, from the Navy Dental Corps, and one from each Constituent Society. Each Constituent Society shall be entitled to one additional delegate if one hundred of its members become regularly enrolled as members of the National Dental Association; and one more delegate for each additional two hundred members enrolled.

Explanatory.—Regardless of enrollment in the National Dental Association each Constituent Society would have one delegate.

With 100 members in the National, two delegates.

With 300 members in the National, three delegates.

With 500 members in the National, four delegates.

With 700 members in the National, five delegates.

With 900 members in the National, six delegates.

With 1100 members in the National, seven delegates.

With 1300 members in the National, eight delegates.

With 1500 members in the National, nine delegates.

In case any States do not affiliate, all members of the National Dental Association residing in such States may meet together at the first meeting of any session of this Association, and elect one delegate to represent them in the House of Delegates.

Sec. 3.—In those states or territories in which more than one society is recognized as a constituent, the total number of delegates from such state or territory shall be computed on the total number of members enrolled in the National Dental Association from such state or territory, or the District of Columbia, and the number of delegates from such constituent societies in each state or territory shall be in proportion to the membership in each.

ARTICLE VI.

Sections.

Section 1.—This Association shall be divided into three sections, as follows:

Section I shall have charge of operative dentistry, nomenclature, literature, dental education and allied subjects.

Section II shall have charge of oral surgery, anatomy, physiology, histology, pathology, etiology, prophylaxis, oral hygiene, materia medica and allied subjects.

Section III shall have charge of prosthodontia, orthodontia, metallurgy, chemistry and allied subjects.

Sec. 2.—New sections may be created or existing sections discontinued or modified by the House of Delegates.

Sec. 3.—There shall also be a State Society Officers' Section, composed of the Presidents, Vice-Presidents, Secretaries and Treasurers of the Constituent Societies. All members of this Section shall retain their active membership for one year after their official connection with their respective Societies, and shall thereafter be honorary members of this Section. All past Presidents of State Societies shall be honorary members of this Section.

ARTICLE VII.

Scientific Foundation and Research Commission.

The Association shall organize and maintain a Scientific Foundation and Research Commission of twenty-five members, who shall be elected by the Board of Trustees.

ARTICLE VIII.

Annual Sessions.

The National Dental Association shall hold an annual session at the time and

place chosen by the House of Delegates. The time and place for the session, however, may be changed by a two-thirds vote of the Board of Trustees, but not later than sixty days prior to the time selected for the session.

ARTICLE IX.

Officers.

Section 1.—The general officers of the Association shall be a President, three Vice-Presidents, a General Secretary and a Treasurer.

Sec. 2.—The officers shall be elected annually by the House of Delegates, to serve for one year, or until their successors shall have been elected and installed.

ARTICLE X.

Board of Trustees.

Section 1.—The Board of Trustees shall have charge of the property and of the financial affairs of the Association. Appropriations for other than ordinary expenses of the Association shall have the approval of a majority vote of the House of Delegates.

Sec. 2.—Three Trustees shall be elected annually by the House of Delegates, each to serve for a period of three years.

Sec. 3.—Each member of the Board of Trustees shall be elected from one of the nine districts into which the constituent societies shall be grouped for this purpose as provided for in Chapter VII, Section 2 of the by-laws.

ARTICLE XI.

Dues and Assessments.

Section 1.—The annual dues in this Association shall be one dollar, payable January 1st, for the ensuing year.

Sec. 2.—Members of the Army and Navy Dental Corps may be elected to full membership, with all privileges, on payment of the annual dues.

Sec. 3.—All members of the National Dental Association in good standing shall receive the Journal free. To members of State Dental Societies, not enrolled in the National Dental Association, the subscription to the Journal shall be two dollars; and to all others the subscription shall be three dollars; provided that if this should be in conflict with the rules of the U. S. Postal authorities the Board of Trustees may reduce the general subscription to two dollars.

Sec. 4.—In case of need, in order to raise funds, the House of Delegates may order an assessment not to exceed two dollars in one year, for each member; or an assessment not to exceed fifty dollars in one year upon each Constituent Society, but not both.

ARTICLE XII.

Amendments.

The House of Delegates may amend or alter this Constitution at any annual session, due notice having been given at a previous meeting of said annual session, provided unanimous consent may be obtained. Otherwise all amendments must lie on the table until the annual session next following their introduction, at which time a two-thirds vote will be requisite for their adoption. In the latter procedure due notice of the substance, or if not too lengthy, the exact wording of the proposed changes must be sent to each member of the House of Delegates with the regular notice of the annual session.

BY-LAWS

CHAPTER I.

Membership.

Section 1.—Active members. The presentation of a properly certified roster of members in good standing of a constituent society, together with the annual dues, shall establish the full membership of each member of this Association.

Sec. 2.—Sixty (60) days after the annual meeting of the Association the General Secretary shall drop from membership roll the names of all whose dues for the current year shall not have been received.

Sec. 3.—A member who becomes a res-

ident of another State, to retain his membership in the National Dental Association, must become a member of the Constituent Society in the State to which he has removed.

Section 4.—Honorary Members.—Dentists who have arisen to pre-eminence in foreign countries shall be eligible to honorary membership. They may be elected by the House of Delegates on nomination by a Section, but not more than three honorary members shall be elected in any one year.

Sec. 5.—Associate Members.—Associate membership may be granted by the House of Delegates to distinguished visitors. Such membership accords all privileges for one year, including the Journal of the Association.

Sec. 6.—Membership of all classes may be declared forfeited by the House of Delegates for reasons considered sufficient by that body.

CHAPTER II.

Registration.

Section 1.—No member shall take part in the proceedings of the Association or of any Sections until he has registered with the General Secretary and secured an official badge of the Association.

Sec. 2.—A member desiring to take part in the scientific work of the Association shall indicate, when registering, the Section in which he wishes to be enrolled.

CHAPTER III.

Admission to Meetings.

Section 1.—Admission to all general sessions, section meetings and clinics of the Association shall be limited to those persons who have received the official badge of the Society, issued by the General Secretary.

Sec. 2.—The General Secretary shall issue membership cards to all active members when their dues are paid, and on the occasion of the annual meeting of the Association shall issue membership badges to such members on presentation of their membership cards, or satisfactory evidence of the fact that such cards have been issued.

Sec. 3.—Membership badges shall be issued to all honorary and associate members, on presentation of satisfactory evidence of such membership.

Sec. 4.—Guest badges may be issued to all visiting dentists from other countries, to physicians, and to non-dental friends of members, at the discretion of the General Secretary.

Sec. 5.—Exhibitors' badges may be issued to exhibitors and their employes.

Sec. 6.—A guest badge may be issued to legally qualified practitioners of dentistry residing within the United States, or its possessions, who are not members of this Association, upon the filing with the General Secretary of a properly signed application for membership, accompanied by the membership fee of this Association and of the Constituent Society in the jurisdiction of which the applicant resides, indorsed by two members of such Constituent Society. Immediately after the meeting of this Association, the General Secretary will forward all such application blanks, together with the amounts paid with each, to the proper officials of the respective constituent Societies, to be acted upon by such Societies under their rules.

CHAPTER IV.

Qualifications, Terms and Registration of Delegates and Alternates.

Section 1.—No one shall serve as a member of the House of Delegates who is not a member of this Association.

Sec. 2.—Delegates and alternates from the Scientific Sections and from the Army and Navy Dental Corps shall be elected for one year.

Sec. 3.—The number of delegates to which each Constituent Society may be entitled shall be based on the number of members from whom dues for the current year shall have been received by the General Secretary of this Association as least thirty days prior to the first day of the annual session of this Association.

Sec. 4. In the cases of those Constituent Societies which do not hold meetings of the current year at least forty-five days prior to the Annual Session of this Association, the number of delegates shall be estimated on the dues for the previous year received by the General Secretary of this Association.

Sec. 5.—To be represented in the House of Delegates the officers of each Constituent Society shall file with the General Secretary of this Association, at least thirty days prior to the first day of the Annual Session, a list of the names of its delegates and alternates.

Sec. 6.—Previous to the Annual Session the General Secretary of this Association shall prepare and have printed a list of the delegates and alternates, elected by the various Constituent Societies; also the number of paid members of each. In case any Society has elected more delegates than the number to which its paid membership shows it to be entitled, the General Secretary, in preparing the list, shall drop one or more names from the list of such Society, beginning at the bottom of the list, until the proper number of names remain.

Sec. 7.—At any election of delegates, the body electing may at the same time elect as many alternates as delegates, and the alternate of each delegate may sit in his stead in the House of Delegates in the absence of the regular delegate from any annual session, except as provided in Section 9 of this chapter.

Sec. 8.—Every delegate must present his credentials and be duly registered by the General Secretary, or other designated officer or committee before taking part in the business of the House of Delegates. Credentials shall include a certificate duly signed by the proper officials of the body delegating him, and such other evidence as may be required.

Sec. 9.—The credentials of a delegate having been accepted and his name placed on the roll of the House of Delegates, he shall remain the duly accredited delegate of the body which he represents until final adjournment of the session, providing that when an accredited delegate finds it impossible to continue his service, his regularly selected alternate shall be entitled to be seated. In the absence of the regular alternate, such vacancy shall be filled by the delegates from such state, from the alternates present.

CHAPTER V.

Procedure of House of Delegates.

Section 1.—*Order of Business.*—The following shall be the order of business, unless changed by unanimous consent:

1. Call to order by the President.
2. Roll call.
3. Reading and adoption of minutes.
4. Reports of officers.
5. Reports of committees.
6. Unfinished business.
7. New business.

Sec. 2.—No new business shall be introduced into the House of Delegates on the last day of the annual session unless with unanimous consent; and such new business, whether in the form of a resolution, memorial or otherwise, shall require a unanimous vote for final action.

Sec. 3.—The House of Delegates shall be governed by Roberts' Rules of Order, when not in conflict with these By-Laws or with the rules of the House.

Sec. 4.—One-fifth of the voting members of the House of Delegates shall constitute a quorum.

CHAPTER VI.

Meetings of the House of Delegates.

Section 1.—The House of Delegates shall meet annually on the day preceding the opening of, and at the same place as, the annual session of the Association.

Sec. 2.—Special sessions of the House of Delegates shall be called by the President, on written request of a sufficient number of delegates to represent a majority of the Constituent Societies by mailing a written or printed notice to

the last known address of each delegate, at least twenty days before such special session is to be held, in which shall be specified the time and place of meeting and in general terms the objects of such special session, and no other business shall be transacted thereat. The time and place for the meeting of a special session must be given in the requests signed by the delegates.

CHAPTER VII.

Nomination, Election and Installation of Officers, Trustees, Honorary Members, Associate Members, Etc.

Section 1.—Nominations for office, except that of Treasurer, shall be made orally, but no nominating speech shall exceed two minutes in length. Any nominee receiving the majority of the votes cast shall be declared elected. The Treasurer shall be nominated by the Board of Trustees, who shall present two names.

Sec. 2.—To carry out the provision in Article X, Sec. 3, of the Constitution, the House of Delegates shall authorize the grouping of the Constituent Societies into nine districts, each district having about one-ninth of the active members of the Association. The House of Delegates may at any session, authorize a revision of such districts, whenever changes in the membership of the Association may indicate the desirability of so doing.

On the occasion of the Annual Meeting of the Association, the delegates from the Constituent Societies in each of those districts in which the term of office of the trustee is about to expire, shall hold a meeting for the purpose of making nominations for a new trustee. Such meeting shall in each case be called by the Trustee whose term is about to expire, or by someone appointed by the President if such Trustee should be absent, and notice of the time and place of such meeting shall be given to each delegate from the particular district.

At such meeting the delegates shall nominate one or more trustees, whose names shall be presented to the House of Delegates. Nominations shall be made under the following rules: In case one member receives the unanimous vote of the delegates of the district, the one name only shall be presented to the House of Delegates as the nominee of the District. In case one member receives a majority vote, the minority delegates may select a second nominee. In case no one member receives a majority vote, after two ballots have been cast, the members receiving the highest, next highest and third highest vote shall be the nominees from such district. The names of the nominees shall be handed to the General Secretary, together with the vote which each nominee received, and both the names and the vote shall be announced to the House of Delegates by the General Secretary. A nominating speech of two minutes may be allowed in behalf of each nominee.

Sec. 3.—All elections shall be by ballot, and a majority of the vote cast shall be necessary to elect. In case no nominee receives a majority of the votes on the first ballot the nominee receiving the least number of votes shall be dropped and a new ballot held. This procedure shall be continued until one of the nominees receives a majority of all votes cast, when he shall be declared elected.

Sec. 4.—The election of officers shall be the first order of business of the House of Delegates after the reading of the minutes of the afternoon of the third day of the annual session.

Sec. 5. Nominations for honorary membership from the Sections shall be referred without debate to the Committee on Sections and Section Work, which shall consider the relative scientific attainments and professional character of the nominees, and shall report its conclusions to the House of Delegates for action. The election of honorary members shall immediately follow the election of officers.

Sec. 6.—Nominations for associate membership may be made by the Sections at any meeting of the House of Delegates, and may be confirmed, with or without reference to the Committee on Sections and Section Work, at the will of the majority of the House of Delegates.

Sec. 7.—The general officers of the Association shall be installed at the close of the last meeting of the annual session, at which they are elected.

CHAPTER VIII.

Officers, Trustees, Research Commission and Committees.

Section 1.— *President.* —The President shall preside at the general meetings and at the meetings of the House of Delegates, and shall perform such duties as custom and parliamentary usage require. On the morning of the first day of the annual session following his election he shall deliver an address at the general meeting not exceeding forty minutes in length.

Sec. 2.— *Vice-Presidents.* —The Vice-Presidents shall assist the President. During his absence or at his request one of them shall officiate in his place. In case of the death, resignation or removal of the President, the vacancy shall be filled by the ranking Vice-President.

Sec. 3.— *General Secretary.* —The General Secretary shall give due notice of the time and place of all annual and special sessions of the Association and of the House of Delegates, by publishing the same in the Journal of the National Dental Association and other Journals. He shall notify members of committees of their appointment, and of the duties assigned to them. It shall be his duty to verify the credentials of members of the House of Delegates and to provide a registration book for them, in which shall be recorded the name of each delegate in attendance at each session. He shall collect all dues and transmit the same to the Treasurer, as may be directed by the Board of Trustees, and as receipt for dues shall issue certificates of membership. He shall conduct all correspondence required of him by the Association or by the House of Delegates, or which may become necessary in the rightful conduct of his office. He shall keep in separate books the minutes of the general meetings and of the House of Delegates. He shall prepare a roll of the delegates attending each session to facilitate voting by roll call. He shall prepare for publication the official programme of each session, and shall perform such other duties as may be directed by the Association or by the House of Delegates, and shall receive a salary to be fixed by the Board of Trustees.

Sec. 4.— *Treasurer.* — The Treasurer shall be the custodian of all moneys, securities and deeds belonging to the Association, and shall hold the same, subject to the direction of the Board of Trustees. He shall give to the Board of Trustees a suitable bond, and shall receive a salary to be fixed by the Board of Trustees.

CHAPTER IX.

Board of Trustees.

Section 1.—The Board of Trustees shall have charge of all properties and of the financial affairs of the Association. At the first meeting of the Board after the annual session of the Association it shall organize. In addition to the nine elected members of the Board of Trustees, the President and General Secretary shall be ex-officio members and shall hold the same positions in the Board as in the Association, but the Board shall elect a Recording Secretary from its own number, who shall keep its records and make its reports.

Sec. 2.— *Journal.* —It shall be the duty of the Board of Trustees to provide for and superintend the publication of the Journal of the National Dental Association, and of all proceedings, transactions and memoirs of the Association, subject to the approval of the House of Delegates. It shall have full dis-

cretionary power to omit from the Journal of the National Dental Association, in part or in whole, any paper that may be referred to it by any of the Sections. It shall appoint a general manager and editor of the Journal, which two positions may be held by one person, and such assistants as may be necessary, and shall determine the terms and conditions of their employment, subject to the approval of the House of Delegates.

Sec. 3. — *Meetings During Annual Sessions.* — During the annual sessions of the Association the Board shall hold meetings as often as may be deemed necessary by the President, and all matters referred to it by the House of Delegates shall be reported on within twenty-four hours, if so ordered by the House.

Sec. 4.—*Board Reports.* — The Board of Trustees shall have the accounts of the Treasurer and of the Journal office audited annually, or oftener if deemed necessary, and shall make an annual report on the same to the House of Delegates, which report shall also specify the character and cost of all the publications of the Association during the year and the amount of all property belonging to the Association.

Sec. 5.—*Vacancies.* — In case of vacancy in the office of Treasurer or Board Secretary, the vacancy shall be filled by the Board of Trustees.

Sec. 6.—*Salaries.* — The Board of Trustees shall fix the salaries of the General Secretary, the Treasurer, the Board Secretary and of the Journal manager and the editor.

Sec. 7.—*Regular Meetings of Board.*— Regular meetings of the Board of Trustees shall be held immediately after the annual session of the Association and at the same place, and on the first Monday in the month of February, of each year, at such place as the Board may select at its first meeting.

Sec. 8. — *Special Meetings of Board.* — Special meetings of the Board of Trustees may be called at any time by the President, or by request of five members of the Board, due notice of which must be given to each member of the Board at least five days in advance of the meeting. The general object of a special meeting must be stated in the notice, and no other business may be transacted.

Sec. 9. — *Annual Sessions, Exhibits, Clinics and General Arrangements.* — The Board of Trustees shall have full control of all arrangements for the annual sessions, and shall provide meeting places for the Association, the House of Delegates and the various Sections. It shall also have control of all clinics and of all exhibits. The Board of Trustees in their discretion may appoint a local committee of arrangements, which shall at all times be under the control of the Board of Trustees.

CHAPTER X.

Scientific Foundation and Research Commission.

Section 1.—This Commission shall consist of twenty-five members, who shall be elected by the Board of Trustees, not more than two of whom shall be from any one state. In addition to the twenty-five members elected by the Board of Trustees, the President and General Secretary shall be ex-officio members. They shall serve for five years, except that of the first Commission, five shall serve for one year, five for two years, five for three years, five for four years and five for five years, as shall be designated when they are elected. They shall meet annually at the time of the meeting of the National Dental Association and as such other times as shall be designated by their executive Board.

Sec. 2. The duties of the Commission shall be to raise funds for carrying on exhaustive dental and oral research; to disseminate scientific knowledge; to support, establish and encourage research and such other duties as shall pertain to the furthering of this cause. They shall

select from their number an Executive Board of five members, which shall, when the Commission is not in session and has not given specific directions, have general control of the administration of the affairs of the Commission and general supervision of all arrangements for administration, research and other matters undertaken or promoted by the Commission. They shall organize and incorporate a corporation to be known as the National Dental Research Foundation and Institute, or such other name as the Commission shall select, which corporation shall receive, invest and disburse all the moneys provided by the Commission and by themselves. They shall organize this corporation in accordance with the laws and requirements controlling such institutions, except that not less than one-third of the trustees of said corporation shall be provided by the National Dental Association. This corporation shall seek bequests, endowments, fellowships and such other contributions as shall perfect the purpose and plan of the National Dental Association. They shall make a written annual report to the Commission and to the National Dental Association.

CHAPTER XI.

Committees.

Section 1.—Committees shall be classified as (a) Standing Committee, (b) Reference Committees, (c) Special Committees. These committees shall be elected by the House of Delegates. The standing committees shall be nominated by the Board of Trustees.

Sec. 2. — *Committees, Appointment and Powers.* — Reference committees shall be nominated from among the House of Delegates, but any member of the Association shall be eligible to serve on standing or special committees. All members of committees who are not members of the House of Delegates shall have the right to present their reports in person to the House of Delegates, and to participate in the debate thereon, but shall not have the right to vote.

Sec. 3. — *Standing Committees.* — Standing committees shall be as follows:

(a) A Judicial Council.
(b) A Committee on Oral and Dental Education.
(c) A Committee on Dental Legislation.
(d) A Committee on Transportation and Place of Session.

Sec. 4. — *Judicial Council.* — The Judicial Council shall be composed of five members. It shall organize by electing a Chairman and a Secretary. The latter shall keep a permanent record of its proceedings, shall conduct all correspondence, etc. The Judicial Council shall hold such meetings during the annual session, and during the year, as it may deem necessary. Three members shall constitute a quorum. It shall make an annual report of its proceedings to the House of Delegates. To this Council shall be referred all questions, complaints, protests and matters of an ethical nature. When such complaints, protests, etc., concern an individual's relations with his local or state society, they shall be considered by this Council only after the same shall have been referred to the Constituent Society concerned, or on an appeal from such Constituent Society. Its decisions shall be subject to appeal to the House of Delegates.

Sec. 5.—*Committee on Dental Education.* —The Committee on Dental Education shall consist of five members. One member shall be elected to serve one year, one for two years, one for three years, one for four years, and one for five years. Thereafter one member shall be elected each year to serve five years. The committee shall organize, shall elect a Chairman and Secretary, and shall adopt such regulations for the government of its actions as it may deem expedient. It shall expend money or contract financial obligations only as shall be au-

thorized in writing by the Board of Trustees. The functions of the Committee on Dental Education shall be: (1) To make an annual report to the House of Delegates on the existing conditions of Dental Education in the United States. (2) To make suggestions as to the means and methods by which the National Dental Association may best influence favorably dental education. (3) To act as the agent of the National Dental Association, under instructions of the House of Delegates, in its effort to elevate the standards of dental education.

Sec. 6.—*Committee on Dental Legislation.* —The Committee on Dental Legislation shall consist of five members. One member shall be elected for one year, one for two years, one for three years, one for four years and one for five years. Thereafter one member shall be elected each year to serve for five years. The committee shall organize, shall elect a Chairman and Secretary, and shall adopt such regulations for the government of its action as it may deem expedient. It shall expend money or contract financial obligations only as shall be authorized in writing by the Board of Trustees. This committee shall have the authority to appoint a sub-committee, consisting of one member from each Constituent Society, and shall have the power to co-operate with the officers of the state and local societies, and with the chief officers of the United States Army and Navy in regard to legislation affecting the welfare of dentistry. The Committee on Dental Legislation shall report to the House of Delegates at each annual session its proceedings during the previous year, and shall recommend such action in respect to pending legislation as it shall deem proper.

Sec. 7. — *Committee on Transportation and Place of Sessions.* — The Committee on Transportation and Place of Sessions shall consist of five members. Invitation for the Association to convene in any city or place shall be presented to this committee, whose duty it shall be to recommend to the House of Delegates the places available for an annual session, with advantages and disadvantages of each. The committee shall secure railroad rates for the annual session, and shall publish same in the Journal of the National Dental Association, and other journals, at the earliest possible time prior to the date of the annual session.

Sec. 8.—*Reports of Standing Committees.* —The reports of standing committees shall, as far as possible, be transmitted to the General Secretary ten days before the date of the annual session, and he shall have them printed for distribution to members of the House of Delegates at the first meeting of the annual session.

Sec. 9.—*Reference Committees.*—(a). Immediately after the organization of the House of Delegates, at each annual session, the President shall appoint from among its members such committees as may be deemed expedient by the House of Delegates. Each committee shall consist of three members unless otherwise provided, the chairman to be specified by the President. The members of these committees shall serve during the session at which they are appointed.

(b) To the appropriate committee shall be referred resolutions, measures and propositions presented to the House of Delegates before final action shall be taken, unless otherwise unanimously ordered by the House of Delegates.

(c) Each reference committee shall, as soon as possible after the adjournment of each meeting, or during the meeting, if necessary, take up and consider such business as may have been referred to it, and shall report on the same at the next meeting, or when called on to do so.

(d) The following reference committees are hereby provided:

1. A Committee on Sections and Sec-

tion Work, to which shall be referred all business relating to the Sections.

2. A Committee on Rules and Order of Business, to which shall be referred all matters regarding rules governing the action, methods of procedure and order of business of the House of Delegates.

3. A Committee on Dental Education, to which shall be referred all matters relating to dental colleges and dental education. The members of the standing Committee on Dental Education shall be ex-officio members of this reference committee.

4. A Committee on Legislation, to which shall be referred all matters relating to state and national legislation. The members of the standing Committee on Dental Legislation shall be ex-officio members of this reference Committee.

5. A Committee on Amendments to the Constitution and By-Laws, to which shall be referred all business relating to this subject.

6. A Committee on Reports of Officers, to which shall be referred the President's address and the Secretary's and Trustees' reports.

7. A Committee on Credentials, to which shall be referred all questions regarding the registration and the credentials of delegates.

8. A Committee on Miscellaneous Business, to which shall be referred all business not otherwise disposed of.

CHAPTER XII.

General Meetings.

Section 1.—*Time of General Meetings.* —The general meetings shall be held at 10:30 a. m. and at 8 p. m. of the first day of the annual session, and at 8 p. m. of the subsequent days.

Sec. 2.—*Addresses.*— At the first general meeting shall be delivered the address of the President, whose recommendations shall thereon go to the House of Delegates for action. The balance of the time of the first meeting shall be devoted to such other addresses as may be provided. The first evening meeting shall be devoted to a paper recommended by Section I, the second evening meeting to a paper recommended by Section II, and the third evening meeting to a paper recommended by Section III.

Sec. 3.—*Order of Business.* —The order of the first general meeting shall be as follows:

1. Calling the meeting to order.
2. Prayer.
3. Address of Welcome and Response.
4. Report of Committee of Arrangements.
5. President's annual address.
6. Literary program.
7. Adjournment.

CHAPTER XIII.

Sections.

Section 1.—*Meetings.*— Each Section shall hold its first meeting at 2 p. m. of the first day of the annual session, and on each subsequent day at 9 a. m., until the program is completed or as the Section may decide; provided that a Section shall hold no meeting that will conflict with the general meetings. The State Society's Officers' Section shall hold its first meeting at 2:00 p. m. on the first day of the annual session.

Sec. 2.—*Officers of Sections.* —The officers of each Section shall consist of a Chairman, Vice-Chairman and a Secretary. These shall serve for one year, or until their successors are elected and qualify; provided that each Section may elect its Secretary to serve a longer time at its discretion. Each Section, except the State Society Officers' Section, shall also elect annually one representative and an alternate to the House of Delegates of the National Dental Association, to serve for one year.

Sec. 3.—*Election of Officers.* —The election of officers of each Section shall be the first order of business of the morning meeting of the last day of each annual session.

Sec. 4. — *Duties of Section Officers.*— (a) Each Chairman shall perform the usual duties of such office, and shall co-operate with the Section Secretary in procuring papers and in the arrangement of the program for his Section. (b) Each Vice-Chairman shall assist his Chairman, and take his place when necessary. (c) Each Secretary shall keep the records of the Section in a book provided for such purpose; shall, with the co-operation of the Chairman, conduct all correspondence necessary to secure papers and perfect the program for his Section; and he shall forward to the General Secretary, at least forty days prior to the date of the annual session, a copy of his Section program for insertion in the official program, and shall perform all other duties pertaining to the office of Secretary.

Sec. 5. — *Executive Committee.* — Each Section shall have an Executive Committee, which shall consist of the last three retired chairmen. In the absence of a member of this committee the acting chairman shall sit in his stead. At the first organization of each Section, in 1913, an Executive Committee of three shall be elected, one to serve for one year, one for two years and one for three years, by which time the Executive Committee will be constituted as above provided. The Executive Committee shall examine and pass on all papers read before the Section, and shall indorse for publication only those that are of scientific or of practical value; it shall also examine all papers offered to the Section, prior to the reading thereof and shall, except in the case of the State Society Officers' Section, choose the one to be read before the general meeting devoted to the work of its particular Section, and such paper shall not be read before the Section meeting.

Sec. 6.—*Honorary and Associate Members.* —Each Section, except the State Society Officers' Section, at its opening meeting, may make nominations for honorary and for associate members, in accordance with Sections 4 and 5 of Chapter I. The Secretary shall immediately notify the General Secretary of such nominations.

CHAPTER XIV.

Papers and Discussions.

Section 1.—Titles and abstracts of papers offered to Sections must be in the hands of the Section Secretary at least forty-five days prior to the annual session.

Sec. 2.—The time allowed for the presentation of a paper before a Section shall be limited to thirty minutes, except by unanimous consent. No one shall address a Section more than once on the same subject, nor for longer than five minutes, except with the consent of the majority of those present.

Sec. 3.—Each Section may provide By-Laws for its own government, provided same do not conflict with the Constitution and By-Laws of the Association.

CHAPTER XV.

Publication.

Section 1.—No paper shall be published as having been read before a Section unless it has received the approval of the Executive Committee of said Section.

Sec. 2.—Each author shall hand his manuscript to the Section Secretary immediately after the reading thereof, and such manuscript must be ready for publication at that time, and must be accompanied by copy for all illustrations needed. The Secretary shall indorse thereon that it has been read, and shall hand it to the Executive Committee for its action. All papers approved by the Executive Committee shall be returned to the Section Secretary, who shall at once forward them for publication to the editor of the Journal.

Sec. 3.—No paper shall be published as having been read before a Section unless it has actually been read, or unless, for special reasons, when the author has been present and prepared to read the

paper, the Section shall vote to have it read by title.

Sec. 4.—All papers and reports presented to a Section, and approved by the Executive Committee, shall become the exclusive property of the Association, provided that the Board of Trustees may permit an author to publish his paper elsewhere than in the Journal of the National Dental Association.

Sec. 5.—*Official Resolutions Approved by the House of Delegates.*—No memorial, resolution or opinion of any character whatever shall be issued in the name of the National Dental Association, unless it shall have been approved by the House of Delegates.

CHAPTER XVI—AMENDMENTS.

Articles of Incorporation.

Section 1.—The House of Delegates at any annual session, wherever the same may be held, may instruct the Board of Trustees to make any changes in the articles of incorporation in accordance with the law, which may appear desirable or which may be made necessary, by any change or amendment to the Constitution and By-Laws of this Association.

Sec. 2.—These By-Laws may be amended on a two-thirds vote of the House of Delegates, provided that no amendment shall be acted on till the day following that on which it is introduced, except that the Board of Trustees may by unanimous vote make such changes, and such changes only, as may be required to adapt them to the rules and regulations of the United States Postal authorities.

CODE OF ETHICS

ARTICLE I.

The Duties of the Profession to Their Patients.

Section 1.—The dentist should be ever ready to respond to the wants of his patrons, and should fully recognize the obligations involved in the discharge of his duties toward them. As they are in most cases unable to correctly estimate the character of his operations, his own sense of right must guarantee faithfulness in their performance. His manner should be firm, yet kind and sympathizing, so as to gain the respect and confidence of his patients, and even the simplest case committed to his care should receive that attention which is due to operations performed on living, sensitive tissue.

Sec. 2.—It is not to be expected that the patient will possess a very extended or a very accurate knowledge of professional matters. The dentist should make due allowance for this, patiently explaining many things which may seem quite clear to himself, thus endeavoring to educate the public mind so that it will properly appreciate the beneficent efforts of our profession. He should encourage no false hopes by promising success when, in the nature of the case, there is uncertainty.

Sec. 3.—The dentist should be temperate in all things, keeping both mind and body in the best possible health, that his patients may have the benefit of that clearness of judgment and skill which is their right.

ARTICLE II.

Maintaining Professional Character.

Section 1.—A member of the dental profession is bound to maintain its honor, and to labor earnestly to extend its sphere of usefulness. He should avoid everything in language and conduct calculated to dishonor his profession, and should ever manifest a due respect for his brethren. The young should show special respect to their seniors; the aged, special encouragement to their juniors.

Section 2.—It is unprofessional to resort to public advertisement, cards, handbills, posters, or signs, calling attention to peculiar styles of work, lowness of prices, special modes of operating; or to claim superiority over neighboring practitioners; to publish reports of cases or

certificates in the public prints, to circulate or recommend nostrums; or to perform any other similar acts. But nothing in this section shall be so construed as to imply that it is unprofessional for dentists to announce in the public prints, or by cards, simply their names, occupation, and place of business, or in the same manner to announce their removal, absence from, or return to business, or to issue to their patients appointment cards, having a fee bill for professional services thereon.

Sec. 3.—When consulted by the patient of another practitioner the dentist should guard against inquiries or hints disparaging to the family dentist or calculated to weaken the patient's confidence in him; and if the interest of the patient will not be endangered thereby, the case should be temporarily treated, and referred back to the family dentist.

Sec. 4. When general rules shall have been adopted by members of the profession practicing in the same localities in relation to fees, it is unprofessional and dishonorable to depart from those rules, except when variation of circumstances requires it. And it is ever to be regarded as unprofessional to warrant operations as an inducement to patronage.

ARTICLE III.

Consultations.

Consultations should be promoted in difficult or protracted cases, as they give rise to confidence, energy, and broader views in practice. In consultations that courtesy and just dealing which is the right of all should be especially observed.

ARTICLE IV.

The Relative Duties of Dentists and Physicians.

Dental surgery is a specialty in medical science. Physicians and dentists should both bear this in mind. The dentist is professionally limited to diseases of the dental organs and adjacent parts. With these he should be more familiar than the general practitioner is expected to be; and while he recognizes the broader knowledge of the physician in regard to diseases of the general system, the latter is under equal obligations to respect his higher attainments in his specialty.

ARTICLE V.

The Mutual Duties of the Profession and the Public.

Dentists are frequent witnesses, and at the same time the best judges, of the impositions perpetrated by quacks, and it is their duty to enlighten and warn the public in regard to them. For this and many other benefits conferred by the competent and honorable dentist, the profession is entitled to the confidence and respect of the public, who should always discriminate in favor of the true man of science and integrity against the empiric and imposter. The public has no right to tax the time and talents of the profession in examinations, prescriptions, or in any way, without proper remuneration.

THE NINE DISTRICTS FOR 1914

The Committee on Amendments submitted to the House of Delegates the following report which gives a list of states in the various districts with the number of members from each state and its total representation in the House of Delegates.

The nine districts into which the constituent societies are grouped for the purpose of electing the Board of Trustees, each district having about one-ninth of the active membership of the Association and entitled to one member on the Board of Trustees.

This report was adopted and the various districts organized and elected their trustee.

No. 1.

Maine	38	1
New Hampshire	16	1
Vermont	40	1
Massachusetts	491	3
Rhode Island	134	2
Connecticut	353	3
	1072	11

No. 2.

New York	1366	8
New Jersey	131	2
	1497	10

No. 3.

Pennsylvania	462	3
Delaware		
Maryland	95	1
West Virginia	37	1
Ohio	1128	7
	1722	12

No. 4.

Virginia	167	2
Dist. of Columbia	110	2
Capitol	30	1
Army	50	1
Navy	2	
North Carolina	78	1
South Carolina	103	2
Georgia	5	
Florida	105	2
Alabama	109	2
Mississippi	158	2
Louisiana	102	2
Porto Rico	34	1
Canal Zone		
	1053	18

No. 5.

Michigan	554	4
Indiana	551	4
Kentucky	315	3
Tennessee	69	1
	1489	12

No. 6

Wisconsin	12	1
Illinois	1766	10
	1778	11

No. 7.

Iowa	590	4
Minnesota	321	3
Nebraska	384	3
North Dakota	118	2
South Dakota	2	
Wyoming	1	1
Montana	64	1
	1480	14

No. 8.

Missouri	515	4
Kansas	301	3
Colorado	133	2
Arkansas	86	1
Oklahoma	184	2
Texas	141	2
Arizona	29	1
New Mexico	31	1
	1420	16

No. 9.

Washington	202	2
Oregon	179	2
California	501	4
S. California	101	2
Idaho		
Nevada		
Utah		
Alaska		
Philippine Islands		
Hawaiian Islands		
	983	10

THE NATIONAL MEETING

By Otto U. King, D. D. S. Huntington, Indiana

WELL, it has come and gone! The eighteenth annual session of the National Dental Association, which was held at Rochester, New York, July 7-10, 1914, was the largest and most significant meeting of the dental profession ever held in the United States. The officers of the National Dental Association and the local committee labored for months in preparing the program and perfecting plans for this great meeting. The program for every day included papers on scientific subjects by the most distinguished members of the dental and medical professions and the large number of clinics given were by men who were final authorities in their respective subjects. The aim of all of those who had anything to do with this program was to make the 1914 meeting the most epoch making in the history of dentistry. The local committee was headed by one of the most enthusiastic workers and best organizers known to the dental profession, Dr. Edward G. Link.

To stage a meeting of such size and variety of purpose so as to meet the requirements of the National Dental Association, no ordinary meeting place would satisfy half the demands of the daily sessions. Rochester, with its great Exposition Park, proved the exception to the rule of cities, being able to afford accomodations for every need. The local committee in charge of the arrangements utilized so satisfactorily the buildings at their disposal at the Exposition Park. Every meeting, clinic, and exhibit space was decided upon and was made to fit the requirements that were to be made during the four days.

In the Peristyles, which were the main entrance to the Exposition Park and to Hall No. 1, was located the general secretary with his corps of twenty-five assistant registrars. All the invited guests, ladies, visitors from the United States and foreign lands and the members of the National Dental Association registered here. One of the Bureaus of Information was also located here.

There were two large assembly halls to meet the needs of the general sessions and all section meetings. The House of Delegates had a special building in which their various sessions were held. The central portion of the large Exposition Hall was occupied by the exhibitors, while the east and west wings were given to the clinics.

Special arrangements were made to furnish luncheon at the Exposition Park Restaurant so that there was no inconvenience or any necessity to return to hotels for midday meals.

DECORATIONS ATTRACTIVE.

Lavender and white were the colors used by the local committee in all their decorating work. In Exposition Hall these colors were artistically blended in each booth. At the head of each white pillar, which marked the booth limits, the seal of the Association wrought in gold with "N. D. A." as an insignia added a wonderful attractive touch to the color scheme. A lion-guarded fountain spouting water in approved dental style, surrounded by a miniature parking—real live ducks, gold-fish, and seats surrounding the same made this large hall unusually attractive. In fact, this Exhibitors' Hall reminded the writer of the Chicago Coliseum during one of its an-

nual automobile shows. A trip through the Exhibitors' Hall proved an interesting experience. Frames of gold in the leaf, worth several thousands of dollars, made a background for the exhibit of a firm a century old. Perhaps the prettiest of all was a long booth containing model dentist's offices. These were fitted up in color schemes of mahogany, gray and white enamel Chairs, cabinets, curtains, everything harmonized. Another stunner was a booth of yellow and green velvet, in which electric lights played and told the story of cements. An exhibit with backgrounds of cylindrical shape in purple and white, in which operated motors, illuminators and compressors, was pleasing to the eye. Perhaps the largest was a booth of stands bearing carborundum. There were tables and trays, coats and towels, casting machines and gas apparatus, sterilizers and syringes, matrices, clamps and crowns, precious metals and plates, regulators and ribbon floss, glassware and germicides, alloys and compressors, malted milk, forceps and foils, aprons and atomizers, typewriters and files, doctors and dentists and salesmen galore to demonstrate and make one feel welcome.

In one booth streams of tooth paste were seen dripping from a tube to spell the firm's name and the word "economy." Here, by an ingenious device, wooden fish and ducks swam in a large pan of water; an artificial mouse played with balls, and a lion and dog danced around on a tray. Above, a cardboard man told of the wonders of certain tooth cleaners. Thus, everything in this Exhibitors' Hall was in a bewildering array and yet very instructive and beneficial. It enabled one unacquainted with dentistry to grasp in some measure the development of the profession.

The manufacturers' representatives were evidently very well pleased with the special arrangements and accommodations that had been made for them as they presented to Dr. Link a diamond scarf pin as a token of their appreciation of the arrangements he had provided for them. A salesman, who represented one of the oldest companies selling dental supplies, informed the writer that in his experience of thirty-five years he had never attended an exhibitors' display that was so elaborate and so carefully planned and carried out even to the minutest detail.

MANY HANDSOME WOMEN.

The local committee planned well for the entertainment of their guests. The women who accompanied their husbands were given books of tickets good for the special entertainments for the four days and they found something to interest them during every moment of their stay in Rochester. There was an exceptionally large number of young and pretty women visitors. Clad in their summery garments of white, pink, or blue, they added a delightful touch of colors to the scenes in the hotel corridors and out at the Exposition Park.

A dozen different banquets and luncheons were held during the four days' meeting. There were several universities that had banquets and all of the various fraternities held banquets and all reported the largest attendance in the history of their various organizations. The decorations and elaborate menu at some of them eclipsed anything in that line ever given at a dental convention.

We feel that special mention should be given the program, in that it was so complete and well arranged that it was necessary for two meetings to be in session at the same time. Then there was the meeting of the House of Delegates and the exhibitors in session continuously. Thus the big Rochester meeting was like a three ring circus. It was impossible for any one to see it all. You had to confine your observation to one ring and be satisfied.

It is impossible in the brief space allotted for this article to go into all the

details of this great meeting or to give to every man and every committee due credit for the work which they did to make this meeting a success. However, editorially and otherwise there will appear in the columns of the Bulletin, from time to time, the complete transactions of the Rochester meeting.

This meeting will go down in the history of the National Dental Association, not so much for what has herein been magnified, as important as it is, but for having established a new high water mark in the history of organized dentistry. The plans for the perfecting of this gigantic organization had been in a transitory state for two or three years and there was an anxious feeling on the part of the leaders for fear something might yet interfere with the successful culmination of the organization. The dental historian of the future will point back to Rochester as the place, where in one year's time, the National Dental Association had grown from a meager membership of less than 1,000 to a gigantic organization of 12,494. Rochester will ever be known as the city where practically every state and territory society in the union became a component of the National and had its representation in the House of Delegates. It was at Rochester where the medical profession clasped hands with the dental for the preservation of health, as was evidenced by the attendance of noted M. D's, who addressed the meetings. Among these speakers were Dr. Victor C. Vaughan, of Ann Arbor, Michigan, president of the American Medical Association; Dr. Joseph Colt Bloodgood, of Baltimore, a Johns Hopkins University professor whose word on cancer is considered final, and Dr. Grover W. Wende, of Buffalo, president of the New York Medical Association, and others.

Yes! The Rochester meeting proved that modern dentistry is making gigantic strides. More education, greater research, better scientific equipment, preventive treatment, corrolation between medical and dental sciences—these were the keynotes of the eighteenth annual convention of the National Dental Association.

Official Bulletin

—OF THE—

National Dental Association

Published Quarterly Under the Auspices of the Board of Trustees.

Entered as second-class mail matter, November 22, 1913, at the Post Office at Huntington, Indiana, under the Act of August 24, 1912.

All contributions and correspondence should be addressed to the General Secretary,
OTTO U. KING, D. D. S.,
Huntington, Indiana.

OFFICERS

Donald Mackay Gallie, President.....Suite 1012, Reliance Bldg., Chicago, Ill.
Edward G. Link, First Vice President.....226 Cutler Bldg., Rochester, N. Y.
L. P. Dotterer, Second Vice President.....102 Broad St., Charleston, S. C.
T. E. Turner, Third Vice President.....St. Louis, Mo.
Otto U. King, General Secretary.....Huntington, Ind.
H. B. McFadden, Treasurer.....3505 Hamilton St., Philadelphia, Pa.

BOARD OF TRUSTEES

Donald Mackay Gallie, President, *Ex-Officio*
Otto U. King, General Secretary, *Ex-Officio*
H. J. Burkhart, '17, Batavia, N. Y.
J. P. Buckley, '17, Chicago, Ill.
Thomas P. Hinman, '17, Atlanta, Ga.
Clarence J. Grieves, '16, Baltimore, Md.
Waldo E. Boardman, '16, Boston, Mass.
Marcus L. Ward, '16, Ann Arbor, Mich.
Thomas B. Hartzell, '15, Minneapolis, Minn.
C. L. White, '15, Oklahoma City, Okla.
S. W. Wherry, '15, Ogden, Utah.

DENTAL JOURNAL COMMITTEE

Herbert L. Wheeler, Chairman.....560 Fifth Ave., New York City.
Otto U. King.....Huntington, Ind.
Burton Lee Thorpe, Secretary.....3605 Lindell Boulevard, St. Louis, Mo.
W. E. Grant.....Starks Bldg., Louisville, Ky.
W. H. G. Logan.....29 E. Madison St., Chicago, Ill.

VOL. 1 OCTOBER, 1914 NO. 4

EDITORIAL

OUR PRESIDENT.

The recent meeting of the National Dental Association held at Rochester, New York, was a great success. Numerically and professionally, it was the best meeting ever held by the National. The Association had before it many important problems and new ones were continually arising. It was to the solving of these problems that the President and Secretary, the Board of Directors, the House of Delegates, and all other officers and committeemen, as well as each individual member present, gave their best thought and attention.

The Constitution provides that the House of Delegates is to elect the officers, which is one of the most important duties of this body; and it is highly essential that the man who is elevated to the Presidency and who is to preside over the affairs and deliberations of this large association, should be one who has had a

broad experience, and he should also be an efficient and capable presiding officer. As announced on the Frontispiece and in the list of officers in this issue of the Bulletin, the election resulted in the elevation of Dr. Donald Mackay Gallie, of Chicago, to this important position.

Like many sturdy Americans, Dr. Gallie was born in Canada, where he received his early education. He graduated from the Chicago College of Dental Surgery with the class of '91, and the following year became a member of the teaching staff, lecturing on Dental Anatomy and later became Associate Professor of Operative Dentistry. In 1901 he was appointed a member of the Illinois State Board of Dental Examiners by Governor Yates, resigning in 1904 to take the chair of Operative Dentistry in the College of Dentistry, University of Illinois, which position he still holds.

Dr. Gallie has been a consistent and faithful worker for the advancement of dentistry; and he possesses marked ability as a presiding officer. Because of this and his genial personality he has been signally honored by his profession. In 1897 he was elected President of the Odontographic Society of Chicago; in 1902 President of the Chicago Dental Society; in 1910 President of the Illinois State Dental Society; 1911 President of the Institute of Dental Pedagogics.

The writer has labored with Dr. Gallie for years in College and Association work, and the members of the National will find that in honoring him with the Presidency they have honored themselves. Let us all look forward to the meeting in San Francisco in 1915; and put forth every effort to assist our President in making this the greatest meeting in our history, to the end that the National Dental Association may maintain the high standard it has now adopted.

J. P. BUCKLEY.

OUR NEW COVER.

The new cover of the Official Bulletin of the National Dental Association is a happy combination of color and symbolism. The value of a standard cover design is great and if to that standard design can be added enough flexibility to make the cover fresh and suitable to every issue the eye is pleased, the heart is gladdened and the mind is quiescent.

The central group of the new cover design symbolizes the purpose of this magazine. It is an expression of the old Greek idea of personification. Beginning with the Greek Key Scroll in the border, we come to the central group of figures. The masculine figure on the left signifies observation and study; the female figure with the torch exemplifies the promulgation of the results of this study and observation and the scribe on the right is setting down the permanent record of the research, and publication of the facts. The sequence of these ideas is congruous and apt. Behind the group, illuminating all is the rising sun of courage, hope and strength. Light

on the dark places, opportunity for work and strength to persist all come from the sun.

THE NATIONAL DENTAL JOURNAL

It is with pleasure that we announce that the preliminary resolution, putting the breath of life into a Journal owned and published by the National Dental Association, was adopted at the annual meeting in Rochester, New York, July 10th.

By this resolution a considerable sum of money is set aside annually to prepare for the publishing of this Journal.

The date set for the issue of the first number is not later than January first, 1916.

A committee of five has been appointed to arrange and prepare for the publishing of this Journal, of which our secretary is a member.

Until such time as the publishing of the Journal is an accomplished fact, our proceedings and announcements will be published in the Bulletin under the control and management of this committee, subject to the approval of the Board of Trustees. Those who are deeply interested in the all around development and advancement of the dental profession will, I am sure, be pleased to hear that this definite step has been taken.

Those who have joined the National Association expecting to receive a publication from it will feel that steps have been taken to fulfill the promises made when the association was reorganized. It is the desire of the National Dental Association, through its committee, to fulfill its pledges in this respect. We must remember, however, that a Journal will not establish and publish itself.

Much arduous work must be done by the committee and others, and the loyal support of the members must be given generously to insure success and the full measure of usefulness possible for a National Dental Journal. The officers of the Association and the Committee will do everything in their power to establish our Journal on a firm foundation and we expect every member to give their loyal support.

NATIONAL JOURNAL TO BE A CONTINUATION OF THE OFFICIAL BULLETIN.

It is the present policy of the Committee on Publication that the Journal of the National Dental Association will be a continuation of the Official Bulletin in every particular, including serial numbers. In view of this fact we advise the profession to retain their bulletins as part of the permanent files of the National Journal. We think it advisable that this statement should be made at this time in order that research workers and others may have no fear of their work

being buried and lost in the Bulletin files. We believe this policy on the part of the Committee meets with the universal approval of the profession.

THE ROCHESTER MEETING.

The Rochester meeting will go down in the history of dentistry as the place where all previous plans for the re-organization of the National Dental Association were consummated. For years the Association had been laboring to perfect an organization that would be so democratic in its form of government that the humblest dentist might have a part in the management of its business affairs. There were some who were skeptical as to whether the House of Delegates composed of such a large number would not be unwieldy and, therefore, impossible to expedite the business of the National Dental Association in a manner looking to the best interests of the organization. We must confess that this argument carried some weight. However, the most pessimistic became very enthusiastic in favor of the plans of organization after they had seen the House of Delegates in session. While it was evident that all were inexperienced in transacting business under our new Constitution and By-Laws, yet it took no prophet to see that the National Dental Association was organized on a scientific business foundation and that the 1916 meeting would see the running of a perfect working organization, expediting the business of the Association in a manner creditable to even the Congress of the United States. In one year's time the National Dental Association had grown from a society smaller than many of our state societies, less than 1000 members, to a gigantic organization of 12,494.

Every one should notice the general secretary's summary in this issue of the Bulletin and see the significance of these figures. Practically every state society is now enthusiastically co-operating as a component of the National. There never was in the history of the profession such an activity in organization work as there is at this very time. Every state in the union is either reorganizing or perfecting its organization. With such a large harmonious organization, the dental profession will be able to courageously meet its future responsibilities.

The dental profession in its Rochester program was honored and its standard of usefulness to humanity was greatly increased by such representative men as appeared on the program from the medical profession, as well as the representative of the governor of the great state of New York. In fact, it was very pleasing to the officers of the Association to have been able to secure such loyal cooperation from the medical profession. We feel that special mention should be given the program, in that it was so complete and well arranged that it was necessary for two sections to be in session at the same time.

The local committee is deserving of special praise for having so perfected their plans that provision was made for the holding of all of the various meetings, clinics, and exhibitors without a single conflict. In this issue of the Bulletin will be found a write-up of the National Dental Meeting at Rochester and from time to time during the year other important phases of this meeting will be taken up and discussed editorially and otherwise through the columns of the bulletin.

The total registration of the Rochester meeting was 3,300, while the total number of delegates seated in the House of Delegates was 114.

PROGRESS OF THE SCIENTIFIC RESEARCHES.

In this issue of the Bulletin we publish the reports of researches of the Scientific Foundation and Research Commission as submitted at the meeting in Rochester. Every dentist interested in the Scientific progress of the dental profession should read and study carefully these reports. Upon the researches of our scientists depend the progress and scientific develpoments of dentistry.

The war in other countries makes it necessary for the world to look to the United States for continued original research work, and progress along all lines.

We, who live in the United States, should thankfully shoulder this responsibility of keeping all lines of research growing, for certainly the present and future developments in humanitarian interests must rest for the time being on our shoulders. It should be, and we are confident it is, more than ever the earnest desire of the Research Commission to push vigorously the problem upon which its workers are now engaged. The Commission should also complete its articles of incorporation and this corporation must serve two purposes, viz:

It must be so stable as to command the respect of not only the dental profession itself, who are giving so freely to its support, but must also command the respect and confidence of men of large means; men who are willing and anxious to contribute to research.

At the same time the Commission must contrive these articles of incorporation in such a fashion that the control of incorporation will rest in the National Dental Association.

The members of our Research Commission have worked steadily towards this end but the task has been a much greater one than would appear from a casual consideration of the proposition.

We can assure all that the Chairman, Dr. Weston A. Price, and his executive committee have devoted much time and thought to the perfection of this most needed instrument. The great value of the work presented by the reports at the Rochester meeting can only be appreciated when one begins to make practical application of the fruits of this labor. How great a debt we owe to these scientists

for their many sacrifices which have and will be made in this work, will never be known except to those who are their intimate friends and thoroughly informed relative to the work of the Commission.

The field for profitable research work is practically unlimited. The scientists and investigators everywhere in our profession report that there is so much to be done that they hardly know where to begin. Since the field is so large and the opportunities so great, the Scientific Commission needs our enthusiastic, financial and moral support.

Every scientist should heartily co-operate and take up some of these scientific problems now waiting for solution. There is room for every scientist. The profession will advance in its usefulness to humanity and to its deserved position among other professions, largely in proportion to the work done by its scientific research workers.

GOVERNMENTAL DELEGATES TO SIXTH INTERNATIONAL DENTAL CONGRESS.

S. J. Resolution 105 passed the House of Representatives July 7th and provided for the acceptance by the United States Government the official invitation of the English Government in connection with the Sixth International Dental Congress, London, England, August 3rd to 8th. This invitation was extended and accepted in behalf of the dental profession of the countries named and farther provided for the appointment, by President Wilson, of fifteen delegates to officially represent the United States at the Congress.

The Resolution was introduced by Senator McLean, of Connecticut. The following: Honorable William J. Bryan, Secretary of State; Senator McLean, of Connecticut; Senators Pomerine and Burton, of Ohio; Speaker Champ Clark, Henry D. Flood, chairman of Committee on Foreign Affairs; Congressman Clement Brumbaugh, of Ohio; Governor Cox, of Ohio; Mayor Curley, of Boston; Congressman George Rauch, Indiana; Congressman James A. Gallison, Massachusetts; and no doubt others, rendered valuable assistance in this Governmental recognition of the dental profession and the National Dental Association and due appreciation to all is hereby expressed.

On July 22nd the following were appointed in accordance with the Resolution:

Barber, Lafayette, Toledo, Ohio.

Boardman, Waldo E., Boston, Mass.

Brophy, Truman W., Chicago, Ill.

Brown, Homer C., Columbus, O.

Burkhart, Harvey, Batavia, N.Y.

Carr, William, New York City, N. Y.

Dowsley, John F., Boston, Mass.

Hartzell, Thomas B., Minneapolis, Minn.

Hinman, Thomas P., Atlanta, Ga.

King, Otto U., Huntington, Ind.

Kirk, Edward C., Philadelphia, Pa.

McManus, James, Hartford, Conn.

Rodgers, Charles W., Boston, Mass.

Smith, T. Sydney, Palo Alto, Cal.

Thorpe, Burton, L., St. Louis, Mo.

DR. BELCHER RE-ENTERS EDITORIAL FIELD.

In the untimely death of Dr. George Edwin Hunt, there became vacant one of the most responsible and important editorial positions in periodical dental literature—one that for the time being seemed difficult if not practically impossible to adequately fill. From the professional and technical standpoints the several publications now in the field meet the dentist's ideals approximately and his practical requirements all but perfectly. But oral hygiene appeals to both the professional man, the layman, and the periodical that caters to this dual audience must give the facts as seen and understood and endorsed by the former in language and style that may be understood and appreciated by the rank and file of the latter. To this end the monthly periodical **Oral Hygiene** has worked since its foundation and to this end it must continue to the fulfillment of its great mission. That it will do this goes without question now that Dr. Hunt's successor has been appointed in the person of Dr. Wm. W. Belcher, of Rochester, N. Y.

Of Dr. Belcher's qualifications little need be said—his splendid work in this field in the past is too well known. He first became interested in this phase of dentistry in the founding of dental clinics for the worthy poor in Rochester, taking upon himself when others failed the work that others had agreed to do—seeing to it that their places were filled or quite as often filling them himself. This meant real interest in the needy, enthusiasm in the work, and often personal sacrifice of time and money to keep the movement alive until its worthiness had been demonstrated to the public, and the public's sympathy aroused and its purse-strings drawn wide open. A means to this end and while the work of the clinics was still in progress was the founding of The Dental Dispensary Record by the Rochester Dental Society, with Dr. Belcher as its Editor. At first its appeals were to the general public—to keep it informed of the Society's work in behalf of the dentally worthy poor and to remind it at times of the need of money to carry on the work. This it did and today the cost of maintenance is largely met by appropriations from the public funds—the goal in mind when the good work was begun. This was great preparation for the work that Dr. Belcher will continue in what is practically a National field. To this work he brings not only knowledge and experience of the things themselves, but the ability to impart it to others to the degree of infection. He wields an easy pen informing, illustrating, convincing. He has the faculty of ingratiating himself into the good will of others, getting

from them just what he most needs and when he most needs it. He also has the equally happy faculty of presenting in meeting what he has in mind for the good of the cause. altogether it is a question if the publishers could have made a more fitting choice for the position so long and ably filled by the late Dr. Hunt.

Of Dr. Belcher's dental pedigree it may be said that he is a graduate of the Philadelphia Dental College (having taken his first course in Washington), member of the Rochester Dental Society, the Seventh District Dental Society, the Dental Society of the State of New York, the National Dental Association, and Vice-Chairman of the Section of Oral Hygiene of the Panama-Pacific Congress. He is a worker in every sense of the word and has the habit of bringing things to pass. That he will infuse new life into Oral Hygiene and the great work the periodical stands for is a foregone conclusion.

SPECIAL NOTICE TO NON-MEMBERS.

This is the last issue of the Official Bulletin that will be sent to non-members.

No dentist who aims to keep in touch with the best in dental literature and the scientific advancement now being made by the dental profession can afford to miss a single issue of this Bulletin. The entire transactions of the National Dental Association, together with the reports of the original work being done by the Scientific Commission, will appear in the Bulletin.

If you have not paid your 1914 dues do so at once through your state society and then your name will not be dropped from the mailing list.

OTTO U. KING,
General Secretary.

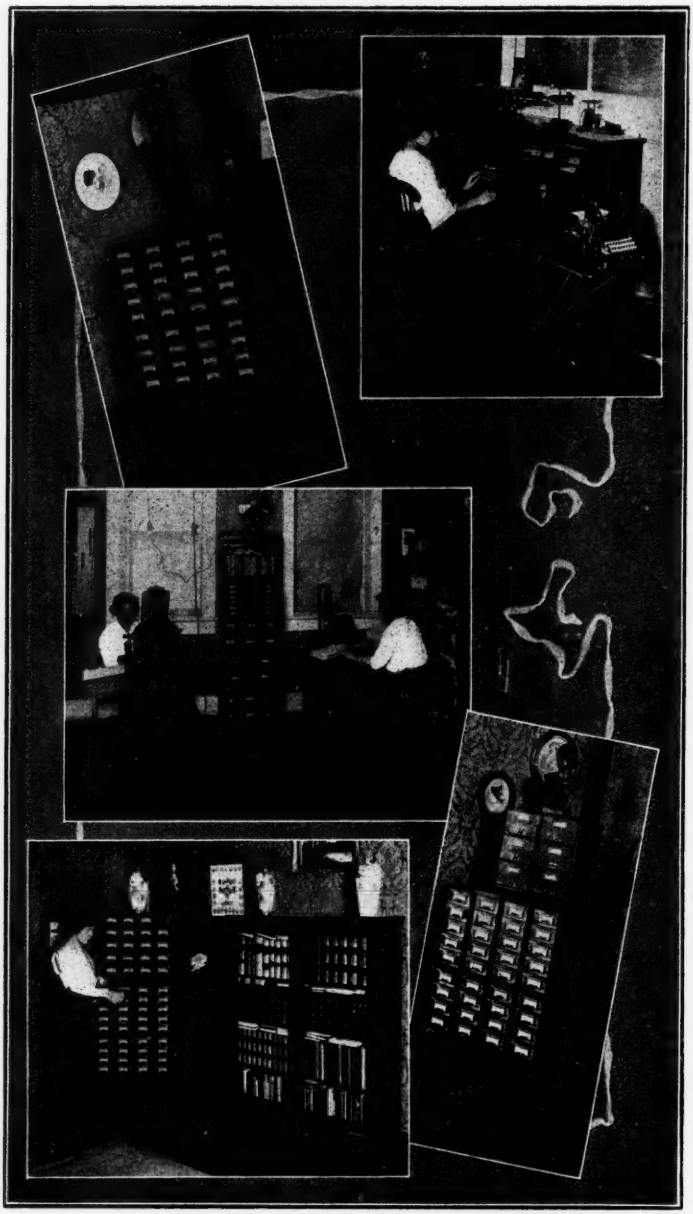
GENERAL SECRETARY'S SUMMARY
FOR 1914-15

State.	President	Secretary	Date and Place of Next Meeting	Membership in N. D. A.	House of Delegates
Alabama	B. S. Searcy Tuscaloosa	J. A. Blue Birmingham	April 13 Montgomery	109	2
Alaska Territory*		Louis L. Keller Skagway			
Arizona	W. A. Baker Tucson	H. H. Wilson Phoenix	Nov. 11-12-13, 1914. Phoenix	29	1
Arkansas	Jno. E. Taylor Little Rock	Wm. B. Dormon Nashville	June 1 Little Rock	86	1
Army Dental Corps	War Department Surgeon General	War Department Surgeon General		50	1
California, State	C. E. Post San Francisco	E. E. Evans Oakland	San Francisco	501	4
California, Southern	G. Maurice Crow Los Angeles	W. E. Sibley Los Angeles		100	2
Canal Zone*		John H. Snapp Panama Camp E. S. Otis			
Colorado	Chas. A. Monroe Boulder	Earl W. Spencer Pueblo	June 17-18-19 Manitou	133	2
Connecticut	Chas. H. Riggs Hartford	Elwyn R. Bryant New Haven	April 20-21-22 Hartford	353	3
Delaware	C. R. Jeffries, Jr. Wilmington	Philip C. Southard Delaware City			
Dist. of Columbia	Chester A. Baker Washington	H. J. Nichols Washington	Washington	110	1
Florida	W. E. Van Brunt Tallahassee	A. M. Jackson Lakeland		106	1
Georgia	E. A. Tigner Milledgeville	M. M. Forbes Atlanta	June Atlanta	5	
Hawaiian Islands*		Edwin M. Kennedy Schofield Barracks			
Idaho	A. A. Jessup Boise	T. B. Carnes Salmon	June	†	
Illinois	J. M. Barcus Carlinville	Henry L. Whipple Quincy	May 11-14 Peoria	1766	10
Indiana	Otto U. King Huntington	A. R. Ross Lafayette	May 18-20 Indianapolis	551	4
Iowa	B. F. Redman Oskaloosa	C. M. Kennedy Des Moines	May 4-6 Waterloo	590	4
Kansas	L. D. Mitchell Arkansas City	A. L. Benton Garnett	Topeka	301	3

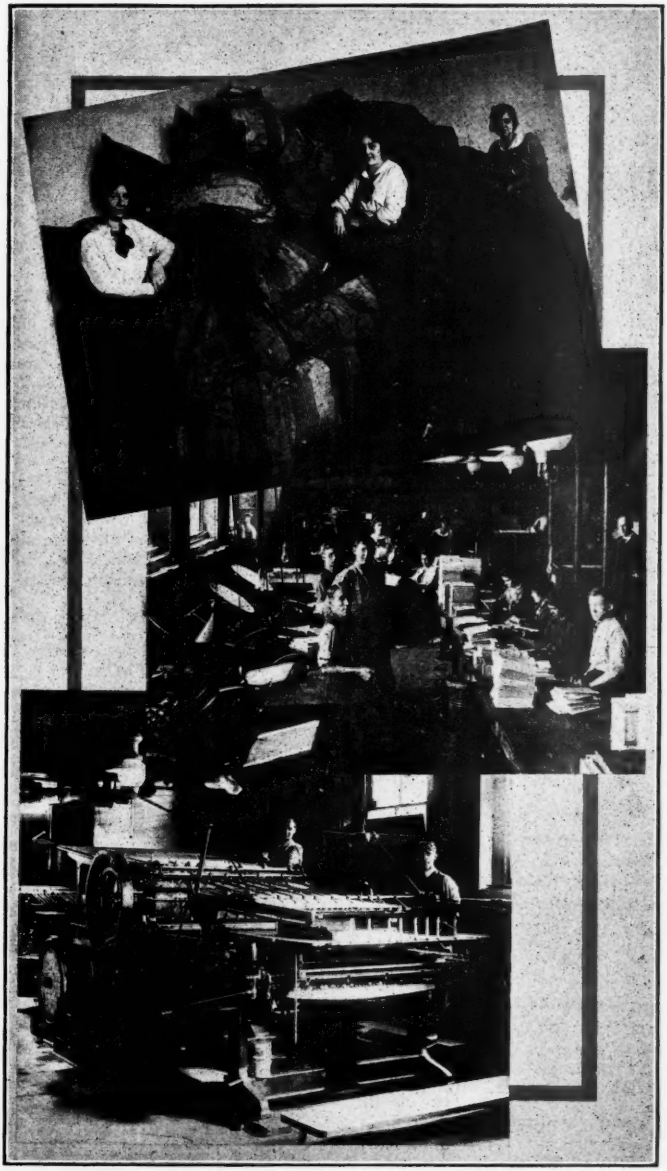
State.	President	Secretary	Date and Place of Next Meeting	Membership in N. D. A.	House of Delegates
Kentucky	O. D. Wilson Owensboro	Chas. R. Shacklette Louisville	June 8-10 Ashland	315	3
Louisiana	Joseph P. Wahl New Orleans	P. Trowbridge Franklin	New Orleans	102	1
Maine	Harry P. Jones Norway	I. E. Pendleton Lewiston		38	1
Maryland	H. H. Streett Baltimore	W. W. Dunbracco Baltimore	December Baltimore	95	1
Massachusetts	Henry H. Piper Somerville	A. H. St. C. Chase Everett	May Boston	491	3
Michigan	Chas. A. Burbridge Grand Rapids	F. Ward Howlett Jackson	April 15-17 Grand Rapids	554	5
Minnesota	F. J. Yerke Minneapolis	Max E. Ernst Minneapolis	Jan 22-23 St. Paul	321	3
Missouri	V. R. McCue Jefferson City	S. C. A. Rubey Warrensburg	April 7-9 Jefferson City	515	5
Mississippi	L. B. Price Corinth	M. B. Varnado Osyka	April 20-22 Jackson	158	2
Montana	R. M. Leslie Great Falls	F. W. Adams Billings	June Glacier Park	64	1
National Capitol	M. M. Dolmage Washington, D. C.	Starr Parsons Washington, D. C.	Sept. 7, 1914 Washington, D. C.	30	1
Navy Dental Corps		War Department Surgeon General		2	
Nebraska	J. H. Wallace Omaha	H. J. Porter Cambridge		384	3
Nevada*					
New Hampshire	C. S. Copeland Rochester	L. I. Moulton Concord	June Weirs	16	1
New Jersey	Walter F. Barry East Orange	John C. Forsyth Trenton	July	132	2
New Mexico	W. J. Armstrong Roswell	J. J. Clarke Artesia	October 5-12, 1914 Albuquerque	31	1
New York	A. M. Wright Troy	A. P. Burkhart Auburn	May 13-14-15 Albany	1366	9
North Carolina	J. A. Sinclair Asheville	R. M. Squires Wake Forest	Wrightsville	78	1
North Dakota	E. N. Hegge Hatton	Tom Smith Langdon	May Fargo	118	2
Ohio	J. K. Douglas Sandusky	F. R. Chapman Columbus	December 1-3, 1914 Columbus	1128	8
Oklahoma	J. M. Temples Tulsa	C. R. Lawrence Enid	March Oklahoma City	184	2
Oregon	H. C. Fixott Portland	F. W. Hollister Portland	No Meeting in 1915	179	2

State.	President	Secretary	Date and Place of Next Meeting	Membership in N. D. A.	House of Delegates
Pennsylvania	J. G. Lane Philadelphia	Luther M. Weaver Philadelphia	June 22-24 Reading	462	3
Philippine Islands*..		Benjamin C. Warfield Los Banos, P. I.			
Porto Rico	J. Lzo Casalduc Arecibo	Rafael Margarida Hudo, San Juan		34	1
Rhode Island.....	Thos. F. McHale Providence	James E. Heap Providence	Providence	134	2
South Carolina.....	D. P. Brooker Columbia	Ernest C. Dye Greenville	April 13-16 Columbia	103	2
South Dakota	J. W. Smoots Spearfish	Thos. E. Johnson Rapid City	May 4-5-6 Rapid City	†2	
Tennessee	David P. Houston Chattanooga	C. O. Rhea Nashville	Sewanee	69	1
Texas	C. M. McCauley Dallas	W. O. Talbot Ft. Worth	May 19-22 Galveston	141	2
Utah	A. C. Wherry Salt Lake City	E. C. Fairweather Salt Lake City	June 21-22 Salt Lake City		
Vermont	Thomas Mound Rutland	P. M. Williams Rutland	May 19-21	40	1
Virginia	A. L. Stratford Richmond	Geo. F. Keesee Richmond	Nov. 4 Richmond	167	2
Washington	S. L. Moak Montesano	A. D. Remington Seattle		202	2
West Virginia.....	W. B. Conaway Clarksburg	J. W. Parsons Huntington	April 14-16 Wheeling	37	1
Wisconsin	Wm. Hopkinson Milwaukee	O. G. Krause Milwaukee	July 13-15 Oconomowoc	12	1
Wyoming*.....		Peter Appel, Jr. Cheyenne			
Totals	.....	.....	.....	12,494	114

*No organization.
†Has not affiliated.



This half-tone shows a part of the office force, with the addressograph and graphotype machines, the filing systems, etc. The General Secretary's private office is not shown.



No. 1: Bulletin ready to mail—75 sacks. No. 2: Binding, stitching and mailing room. No. 3: Bulletin press.

Officers and Committees

—OF THE—

National Dental Association

(Elected and appointed at Rochester, N. Y., July 7-10, 1914.)

OFFICERS

Donald Mackay Gallie, President.....Suite 1012, Reliance Bldg., Chicago, Ill.
Edward G. Link, First Vice President.....226 Cutler Bldg., Rochester, N. Y.
L. P. Dotterer, Second Vice President.....102 Broad St., Charleston, S. C.
T. E. Turner, Third Vice President.....St. Louis, Mo.
Otto U. King, General Secretary.....Huntington, Ind.
H. B. McFadden, Treasurer.....3505 Hamilton St., Philadelphia, Pa.

BOARD OF TRUSTEES

Donald Mackay Gallie, President, Ex-Officio
Otto U. King, General Secretary, Ex-Officio
H. J. Burkhart, '17, Batavia, N. Y.
J. P. Buckley, '17, Chicago, Ill.
Thomas P. Hinman, '17, Atlanta, Ga.
Clarence J. Grieves, '16, Baltimore, Md.
Waldo E. Boardman, '16, Boston, Mass.
Marcus L. Ward, '16, Ann Arbor, Mich.
Thomas B. Hartzell, '15, Minneapolis, Minn.
C. L. White, '15, Oklahoma City, Okla.
S. W. Wherry, '15, Ogden, Utah.

SECTION OFFICERS

Section I.

H. E. Friesell, Chairman, 1206 Highland Bldg., Pittsburg, Pa.
E. G. Coolidge, Vice-Chairman, 59 E. Madison St. Chicago, Ill.
DeLos L. Hill, Secretary.....Atlanta, Ga.

Section II.

Chalmers J. Lyons, Chairman..Ann Arbor, Mich.
F. B. Moorehead, Vice-Chairman, People's Gas Bldg., Chicago, Ill.
Mark E. Vance, Secretary, Fraternity Bldg., Lincoln, Neb.

Section III.

C. W. Mills, Chairman, Chillicothe, Ohio.
L. E. Custer, Vice-Chairman 28 North Ludlow St., Dayton, Ohio.
W. Ernest Walker, Secretary, 157 Baronne St., New Orleans, La.

STATE SOCIETY OFFICERS' SECTION.

Benjamin Sandy, Chairman, Syndicate Bldg., Minneapolis, Minn.
C. R. Lawrence, Vice-Chairman, Enid, Oklahoma.
A. P. Burkhart, Secretary, 53 Genesee St., Auburn, N. Y.

COMMITTEES

Judicial Council.

J. R. Callahan, 25 Garfield Place, Cincinnati, O.
R. Ottolengui, 80 W. 40th St., New York City.
Victor S. Jones, Bethlehem, Pa.
Arthur D. Black, 1533, 122 S. Michigan Ave., Chicago, Ill.
Charles H. Oakman, 27 Grand River Ave., Detroit, Mich.

Dental Education.

H. E. Friesell, Chairman, 1206 Highland Bldg., Pittsburg, Pa.
Leuman M. Waugh, Secretary, 576 Fifth Ave., New York City.
C. C. Allen, 10th & Troost, Kansas City, Mo.
Shirley W. Bowles, 1616 Eye St., Washington, D. C.
Fred W. Gethro, 917 Marshall Field Bldg., Chicago, Ill.

Dental Legislation.

Homer C. Brown, 185 E. State St., Columbus, O.
C. B. Gifford, Grandby St., Norfolk, Va.
A. O. Ross, 807 N. High St., Columbus, Ohio.
Herbert L. Wheeler, 560 Fifth Ave., New York City.
Charles R. E. Koch, 31 W. Lake St., Chicago, Ill.

Transportation and Place of Sessions.

Victor H. Jackson, 40 E. 41st St., New York City.
H. F. Hoffman, 321 Metropolitan Bldg., Denver, Colo.
Joseph D. Eby, 519 Grant Bldg., Atlanta, Ga.
D. C. Bacon, 31 N. State St., Chicago, Ill.
Henry Woods Weirick, 503-4 Mechanics Bldg., San Francisco, Cal.
J. P. Marshall, 7401 Hazel Ave., Maplewood, St. Louis, Mo.

Ad-Interim Committee.

Donald Mackay Gallie, Suite 1012 Reliance Bldg., Chicago, Ill.
Otto U. King, Huntington, Ind.
J. P. Buckley, 163 State St., Chicago, Ill.
H. J. Burkhart, Batavia, N. Y.
Marcus L. Ward, Ann Arbor, Mich.

Dental Journal.

Herbert L. Wheeler, 560 Fifth Ave., New York City.
Otto U. King, Huntington, Ind.
Burton Lee Thorpe, 3605 Lindell Boulevard, St. Louis, Mo.
W. E. Grant, Starks Bldg., Louisville, Ky.
W. H. G. Logan, 29 E. Madison St., Chicago, Ill.

Public Health.

M. F. Finley, Chairman, 1928 I St., N. W., Washington, D. C.
S. W. Bowles, Vice-Chairman, 1616 I St., N. W., Washington, D. C.
W. Smith Frankland, Secretary, The Burlington, Washington, D. C.
W. Clyde Davis, Lincoln, Neb.
W. A. White, Phelps, N. Y.
S. A. Long, McAlester, Okla.

Scientific Foundation and Research Commission.

Weston, A. Price, Cleveland, Ohio.
Thomas P. Hinman, Atlanta, Ga.
Clarence J. Grieves, Baltimore, Md.
John V. Conzett, Dubuque, Iowa.
Eugene R. Warner, Denver, Colo.
Edward C. Kirk, Philadelphia, Pa.
William Carr, New York City.
Truman W. Brophy, Chicago, Ill.
G. V. Black, Chicago, Ill.
Homer C. Brown, Columbus, Ohio.
Thomas B. Hartzell, Minneapolis, Minn.
Arthur R. Melendy, Knoxville, Tenn.
Edward S. Gaylord, New Haven, Conn.
Henry C. Ferris, New York City.
Charles C. Allen, Kansas City, Mo.
Frank O. Hetrick, Ottawa, Kans.
Marcus L. Ward, Ann Arbor, Mich.
Frank L. Platt, San Francisco, Cal.
C. S. Van Horn, Bloomsburg, Pa.
R. H. Volland, Iowa City, Iowa.
*George E. Hunt, '20, Indianapolis, Ind.
Samuel H. McAfee, '20, New Orleans, La.
P. M. Williams, '20, Rutland, Vt.
G. T. Williams, '20, Seattle, Wash.
W. T. Farrer, '20, Louisville, Ky.
Donald Mackay Gallie, Ex-Officio, Chicago, Ill.
Otto U. King, Ex-Officio, Huntington, Ind.

Pharmacopoeial.

M. F. Finley, Chairman, 1928 I St., N. W., Washington, D. C.
A. H. Peck, Chicago, Ill.
Joseph Head, Philadelphia, Pa.

National Relief Fund.

Edward S. Gaylord, Chairman, New Haven, Conn.
L. G. Noel, 527 Church St., Nashville, Tenn.
William T. Chambers, Denver, Colo.
James McManus, Hartford, Conn.

---

*Deceased.

ANNOUNCEMENTS AND ITEMS OF INTEREST

INTERNATIONAL.

International Dental Federation, San Francisco, Cal., August 30, 1915.

NATIONAL SOCIETIES.

American Institute of Dental Teachers, Ann Arbor, Mich., January 28-30, 1915.

Panama-Pacific Dental Congress, San Francisco, Cal., August 30-Sept. 9, 1915.

National Dental Association—House of Delegates, August 30-Sept. 9, 1915, San Francisco, Cal.

STATE SOCIETIES.

(See General Secretary's Summary on pages 163, 164, 165.)

SPECIAL NOTICE.

Transportation to Panama-Pacific Dental Congress—Special Train.

The transportation committee in conjunction with the ad-interim committee of the National Dental Association will hold a meeting in the near future in Chicago to perfect arrangements for running a special train to the Panama-Pacific Dental Congress at San Francisco, California.

We urge all other transportation committees, appointed from the various organizations, to confer with this committee of the National before completing their arrangements or signing contracts. Such a conference will undoubtedly save confusion and be in a position to secure better accommodations, itineracy and rates.

OTTO U. KING,
General Secretary,
Huntington, Indiana.

FEDERATION DENTAIRE INTERNATIONAL.

At the annual meeting of the International Dental Federation, London, England, August 6 1914, the following officers were elected for 1914-15.

Honorary President—W. B. Patterson, London.

President—Truman W. Brophy, Chicago.

Vice-Presidents—Harvey J. Burkhart, Batavia, N. Y.

F. Schaeffer, Stuckert, Frankfort-on-Main.

M. Roy, Paris.

W. Guy, Edinburg.

Rudolph Weiser, Vienna.

Vincenzo Guerini, Naples.

J. Howard Mummery, London.

N. Etchepareborda, Buenos Ayres.

Ernest Jessen, Strassburg.

Secretary-General—Florestan Aguilar, Madrid.

Assistant Secretaries—Burton Lee Thorpe, St. Louis.

C. Van der Hoevax, The Hague.

G. Villain, Paris.

B. Landete, Madrid.

Treasurer—Edmond Rosenthal, Brussels.

NEXT PLACE OF MEETING, SAN-FRANCISCO, AUGUST 30, 1915.

BURTON LEE THORPE,
Assistant Secretary.

DENTAL PROTECTIVE ASSOCIATION OF THE UNITED STATES. NOTICE.

The Dental Protective Association of the United States as most of the older members of the profession know, was organized by Dr. J. N. Crouse, of Chicago, in December 1888. The work

which this Association has done in protecting its members, and incidentally the entire dental profession, from the unjust demands of patentees whose claims were worthless, is a matter of history.

The Association holds its annual meetings in Chicago, on the third Monday in December, at which time the financial report is given and all matters pertaining to the Association are freely discussed.

In view of the fact that certain statements are being circulated in the profession to the effect that the Dental Protective Association is no longer in existence, the present officers of this Association deem it advisable to correct these mis-statements. This Association is still in business. With the exception of the reorganized National Dental Association it is the largest dental organization in the world. Its membership is composed of thousands of dentists in the United States. There is something like twenty-five thousand dollars cash in the Treasury to be used whenever necessity arises for the purpose for which the Association exists.

In September, 1911, Dr. Crouse read a paper before the Chicago Dental Society on, "Patents and Patent Litigation of the Dental Profession, Past and Present." This paper was subsequently published in the Dental Review and a reprint was mailed to the entire profession. In this paper Dr. Crouse reviewed the history of the Dental Protective Association. He also called attention to an agreement which he had effected with Dr. W. H. Taggart, by the terms of which members of the Association, under the conditions mentioned in the agreement, could obtain permission to practice the Taggart method for the lifetime of the patients (17 years) with any machine he may then be using for the cash sum of $15.00. This agreement also provided that any member of the profession who joined the Association within the time specified could procure such permission on the same terms. The agreement was made on the FIFTH day of DECEMBER, 1910; and the time limit expired, except for recent graduates, FEBRUARY NINTH, 1913.

The object of this notice at this time is not only to refute the unjust and untruthful statements referred to above; but also to answer the many questions which are coming in as to whether or not members of the profession can still join the Dental Protective Association. Subject to the approval of the Board of Directors, any member of the Dental profession may become a member of the Association on payment to the Treasurer of a membership fee of Ten ($10.00) Dollars, and subscribing to the By-Laws of the Association; but it must be with the distinct understanding that the time limit of the agreement with Dr. Taggart has expired, except for recent graduates or those who have not been in the practice of dentistry for more than one year. A clause in the agreement provided as follows:

"That those who enter the profession within one year from the date of the first court decision sustaining the validity of patents heretofore mentioned shall pay Fifteen ($15.00) Dollars for the permission to practice the Taggart method; those that enter the profession from year to year thereafter shall have the fee reduced by as many dollars as the number of years elapsed since the first court decision sustaining the validity of said patent. One year from date of graduating or entrance into the profession, in all cases, shall be given in which to pay the stipulated fee."

DENTAL PROTECTIVE ASSOCIATION OF THE UNITED STATES.

J. G. Reid,
D. M. Gallie,
J. P. Buckley,
Board of Directors.

THE PANAMA PACIFIC DENTAL CONGRESS.

The Committee of Organization of the Panama Pacific Dental Congress wishes it distinctly understood that the Panama Pacific International Exposition will not be postponed, but will open on time, as will also the Panama Pacific Dental Congress. The authority for this statement is impressed in the following letter from President Moore of the Exposition Company:

To the Commissioners from Foreign Nations and from the States and Territories of the United States to the Panama-Pacific International Exposition.

Gentlemen:—

There have been reports that the Exposition, because of the war in Europe, would be postponed. It will not be postponed.

There have been published statements that the war in Europe would seriously affect the commercial or educational importance or the financial success of the Exposition. They will not be so affected.

The Exposition will open on its scheduled date—February 20th, 1915. It will be completely ready when open. It is more than ninety per cent completed today. Nothing will be permitted to interfere with the consummation of the plans originally laid down.

Many friends and parties in interest have presented arguments in support of postponement for a year. These have been given anxious study and careful analysis. Most of them are merely counsels of timidity, based on nothing save a general feeling of doubt and uncertainty. These are sufficiently answered by saying that there is no longer any doubt or uncertainty as to the success of the exposition whatever the situation in Europe may be. Other arguments for postponement have some practical foundation, but for every one of these there is a stronger and better argument for proceeding with our plans.

The Exposition will, therefore, open as scheduled. There is not the slightest reason to believe its success, in any phase, will be any less than that which was so certain before European war broke out. Not one of the nations at war have notified us of an intention to withdraw her participation; France and Italy have in fact notified us that their plans remain unchanged, but even if we should lose the others the interest and importance of the Exposition would still as a whole, surpass all precedent.

As to the Domestic participation, the effect of the European war seems likely to rather advantageous than otherwise. The stimulus on exhibits is already felt, as American manufacturers become impressed with the opportunity given by the Exposition for bringing their goods to the attention of the large distributors of Central-South America, the Orient and Canada.

As to attendance, all expert opinion agrees that there is nothing in the situation, even if continued through 1915, that will affect seriously the willingness or ability of the people of the Western Hemisphere and of the far East to visit the Exposition. Some opinion is firm that travel to California may even be increased by the war. The decision of the Exposition management, has, however, been reached without regard to that consideration. We consider it our duty alike to our nation, to the participating nations, to our exhibitors and to ourselves to carry out the plans as originally laid down and which, now nearly at fruition, promise the most important, the most beautiful Exposition in history.

(Signed) CHAS. C. MOORE,
President.

NATIONAL DENTAL ASSOCIATION.

We take special pleasure in noting the meeting of this organization, the analogue of the American Medical Association, in Rochester, July 7 to 10. The close affiliation of Dentistry with Medicine and both the professional and the practical need of making this bond still more close, are expressed by the invitation to several prominent physicians to address the meeting. It is significant that the subjects chosen are of a highly practical nature; they typify the need of joint professional discussion of common points of scientific observation and therapeutics. The medical profession is cordially invited to attend the meetings and we trust that physicians will be largely represented at Rochester.

This may be an appropriate occasion to remind both professions that they are not more widely separated, even in regard to matters of technical interest, than are the various specialties of the medical profession. It is a matter of convenience that Dentistry is organized as a separate profession, with a special degree conferred by separate schools. In professional polity, even in scientific foundation, the two professions are virtually one.

It may be well claimed that inventive genius and mechanical skill have reached their highest development in dentistry. It may also be claimed that in rapidity of development of professional spirit, of scientific discoveries and their adaptation to practical therapeutic ends, and of that very important item in any business or profession, the accomplishment of satisfactory practical results, dentistry has surpassed every other vocation, with the possible exception of electric engineering and certain limited fields in other professions. And we take pride in the fact that dentistry is historically, a science and a profession that belongs especially to the United States of America. The very frank and general admission of this fact in Europe has undoubtedly reflected prestige on the medical profession itself.—*Editorial, Buffalo Medical Journal, June, 1914.*

SOME STARTLING FACTS.

"About two and a half million babies are born in the United States each year. Nearly half a million die in their first year, and half of all are dead before they reach their twenty-third year, before they have had a chance to do either much good or evil in the world. Of the one and a quarter million who live, a certain proportion will become industrious citizens of average ability, and the smaller proportion will be the leaders of men, the doers of deeds, while there will be a very definite proportion that will, by reason of their heredity, become criminals, epileptics, paupers, alcoholics. The other more healthy and able people of the United States have to support these incapable ones. There are about a million insane and epileptic feeble-minded, blind and deaf; there are 80,000 prisoners and 100,000 paupers—all of whom cost the United States over a hundred million dollars a year."—*Hygiene and the Child.*

SHORT PAPERS THE BEST PAPERS.

When you write a paper, make it short and to the point. The Publication Committee has recently given careful consideration to the large number of scientific articles which are every year submitted for use in The Journal. We have been tremendously impressed with the fact that, with certain exceptions, the short papers are the best papers. Writers who have something to say seem to be able to condense their thoughts. The paper is given strength and lent interest by this condensation.

The physician of today is a busy man. He has no time to devote to long winded

articles. The author who presents his case in a paper of from 2,000 to 2,500 words is certain to attract a much wider audience than a man who uses five to seven thousand words.—*Editorial in September issue of The Ohio State Medical Journal.*

STRENGTHENING EDUCATIONAL REQUIREMENTS.

In every branch of the professional work the modern tendency is toward strengthening educational requirements, thereby increasing the efficiency of the practitioner.

At the recent meeting in Rochester of the National Dental Association, the president, Dr. Homer C. Brown of Columbus, strongly emphasized this point and recommended that as quickly as possible another year be added to the curriculum of the dental schools. At present all of the dental colleges present their course in three years. Dr. Brown recommended that this time be extended to four years, and that through this extension more time be devoted to the subjects of history, pathology and bacteriology. He emphasized the need of a better knowledge of these fundamental branches on the part of the practicing dentists.

He further emphasized another point that has been recommended in medical education—that all professional education should be offered by state universities or universities of like standing.

The Rochester meeting, which was the first since the reorganization of the National Dental Association, again demonstrated the cordial relations existing today between the medical and dental professions. Before this association, which has increased in membership during the last two years from a few hundred to more than 12,000, appeared several men prominent in the medical profession—Dr. Victor C. Vaughan, president of the American Medical Association; Dr. Joseph C. Bloodgood, of Baltimore; Dr. Grover W. Wende, president of the New York State Medical Society, and others. These men, in their addresses, emphasized the close relation of the physician and the dentist, and the advantages of co-operation.—*Editorial in August issue of The Ohio State Medical Journal.*

THE SWINDLER ARRESTED.

We desire to call the attention of the dental profession to excerpts from circular letters sent out by the American Dental Trade Association. This swindler has been victimizing dental depots throughout the country and in some instances has robbed dentists.

In Cleveland this same swindler is said to have stolen a gold plate with platinum attachments from the office of Dr. ————, whom he made use of as his means of introduction to the dental depots. In Philadelphia he secured introduction through Dr. ————.

His plan was a very clever one indeed and in Philadelphia he even went so far as to secure the services of a local attorney to present the terms of an agreement covering his post graduate course to Dr. ————. All of which was done merely to make his scheme plausible.

Report has reached the office of the American Dental Trade Association from two different cities to the effect that an individual giving the name of G. R. Fletcher, posing as a dentist from Australia, is trying to obtain goods by plausible means and in one city secured material and equipment ostensibly for export but with local delivery.

When confronted by representatives of two of the houses he bolted from the office where the goods were delivered and was followed by detectives. They lost Fletcher but recovered most of the goods.

His plan is to go to some highly repu-

table dentist in each city and arrange with him for a special course in crown and bridgework, or other specialty and through this dentist secure introduction to the dental depots.

He is described as being a tall man, over six feet, with a decided English accent, smooth face, and has a silicate filling in superior left cuspid.

This man Fletcher was arrested in Indianapolis on September 1st, where he was attempting to obtain goods.

It has now been ascertained that he has operated in Seattle, San Francisco, New York, Chicago, Boston, Buffalo, Cleveland, Detroit, Philadelphia and probably in other places still unreported.

He is to be tried in Buffalo and in order to prove that his operations are criminal it will be necessary to show that he has obtained goods under false pretense in various cities. The charge against him in Buffalo alone will not hold him unless it is shown to the court that the Buffalo dealer concerned is but one of numerous victims of the very clever criminal.

Therefore, it is desired that every dealer or dentist who has been approached by this man, who is known to have operated under the names of Fletcher, Anderson and Harper, shall send a sworn statement of the circumstances to the Webster Dental Company, 700 Main Street, Buffalo, N. Y.

It does not make any difference whether or not goods were actually obtained from you by this individual, but what the American Dental Trade Association wishes to establish is the fact that he has attempted to obtain goods in various cities and has succeeded in some instances through the operation of the plan outlined.

Delay may cause his release and he will again become a prey upon the trade.

We are of the opinion that a warning to the dental profession, such as this one, against similar schemes, may prove beneficial. It behooves the dental profession to eradicate from itself the odium of "easy marks."

NEWSPAPER COMMENT.

The following article appeared as an editorial in the Asbury Park Press. A few more such articles in the newspapers throughout the State might aid in bringing about the desired result:

"The New Jersey dentists want the State to appoint a member of the State Dental Society to the State Board of Health.

The fact that dentistry has no representation on the State Board of Health is taken to be unfair to the science that so nearly concerns the public health. A well posted dentist on the State Health Board, we imagine, might do a great deal for the public health. The science of dentistry has proven that many diseases to which the people are subject are attributable to neglected and decayed teeth. There are health situations that make it desirable that inspections include an examination of the teeth, that methods desirable for the preservation of the teeth and the correction of latent disorders due to their neglected condition be either adopted or be made part of the oversight and official work of the State Board of Health. If a dentist is to be added to the State Board it is eminently proper he be appointed from the State Dental Society, whose members may be counted on to commend the best man for the place."—*August issue of the New Jersey Dental Journal.*

The Municipal Auditorium in San Francisco, costing $1,000,000.00, exclusive of the land on which it stands. One of the finest auditoriums in the world. An ideal location for the great Panama-Pacific Dental Congress, August 30th to September 9th, 1915.

PANAMA PACIFIC DENTAL CONGRESS

SAN FRANCISCO, CALIFORNIA

August 30 to September 9, 1915

The Panama Pacific Dental Congress will be held in the new Municipal Auditorium in the Civic Center of San Francisco. This building covers an entire city block, and contains every modern convenience necessary for holding a great dental convention. Its main hall will seat 12,000 persons; 6,000 in the balcony and 6,000 on the floor. The latter space, 198x200 feet, will be occupied by the exhibitors. Some of the general sessions of the Congress will be held in the balcony. There are 10 smaller halls, which have a capacity from 400 to 1200 each. Enough of this space will be at the disposal of the Congress to accommodate the various sessions of the Congress; the clinics and meetings of all sections; the House of Delegates of the National Dental Association; the American Society of Orthodontists; Salt Lake County Dental Society; California State Dental Association; all educational exhibits; Delta Sigma Delta; Psi Omega and Xi Psi Phi Fraternities. In fact, all societies which meet in San Francisco as a part of the Dental Congress will be accommodated in this beautiful building, which is one of the finest auditoriums in the world.

The accommodations for staging this great Congress are ideal, and the fact must not be overlooked that all its sessions, clinics, and exhibits will be held in one great building, easily accessible from every part of San Francisco. No dentist can afford to stay away from this greatest Dental Congress of the Age.

COMMITTEE ON ORGANIZATION,

FRANK L. PLATT, Chairman,
323 Geary St., San Francisco, Cal.

ARTHUR W. CHANCE, Vice-Chairman,
Corbett Bldg., Portland, Ore.

ARTHUR M. FLOOD, Secretary,
240 Stockton St., San Francisco, Cal.

The Magic Words

By Berton Braley

How can you climb from the crowd and the press
Up where the mighty ones sit?
What are the magical words of success?
ENERGY, HUMOR and GRIT!
ENERGY, spurring you forward to meet
Life and the luck she may send,
HUMOR which laughs in the face of defeat,
GRIT which fights on to the end!

ENERGY firing the heart and the brain
Thrilling each fibre with vim,
HUMOR, which keeps a man sanguine and sane,
GRIT, which is dogged and grim;
These are the magical tokens, no less,
These are the keys that will fit,
Into each lock on the doors of success,
—ENERGY, HUMOR and GRIT!

—Key Publishing Co.

The Magic Words

By Berton Braley

How can you climb from the crowd and the press
Up where the mighty ones sit?
What are the magical words of success?
ENERGY, HUMOR and GRIT!
ENERGY, spurring you forward to meet
Life and the luck she may send,
HUMOR which laughs in the face of defeat,
GRIT which fights on to the end!

ENERGY firing the heart and the brain
Thrilling each fibre with vim,
HUMOR, which keeps a man sanguine and sane,
GRIT, which is dogged and grim;
These are the magical tokens, no less,
These are the keys that will fit,
Into each lock on the doors of success,
—ENERGY, HUMOR and GRIT!

—Key Publishing Co.